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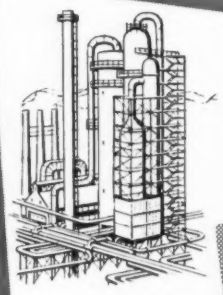

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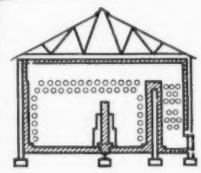

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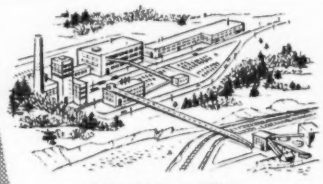

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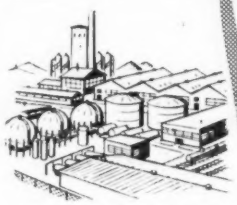

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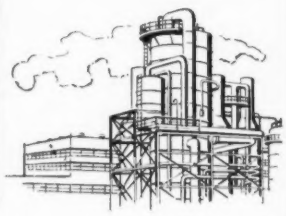

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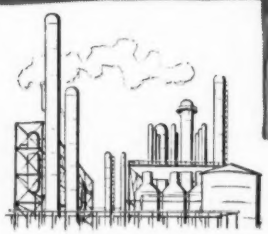

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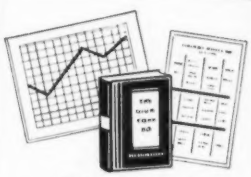

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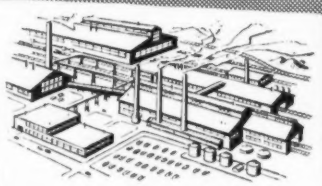

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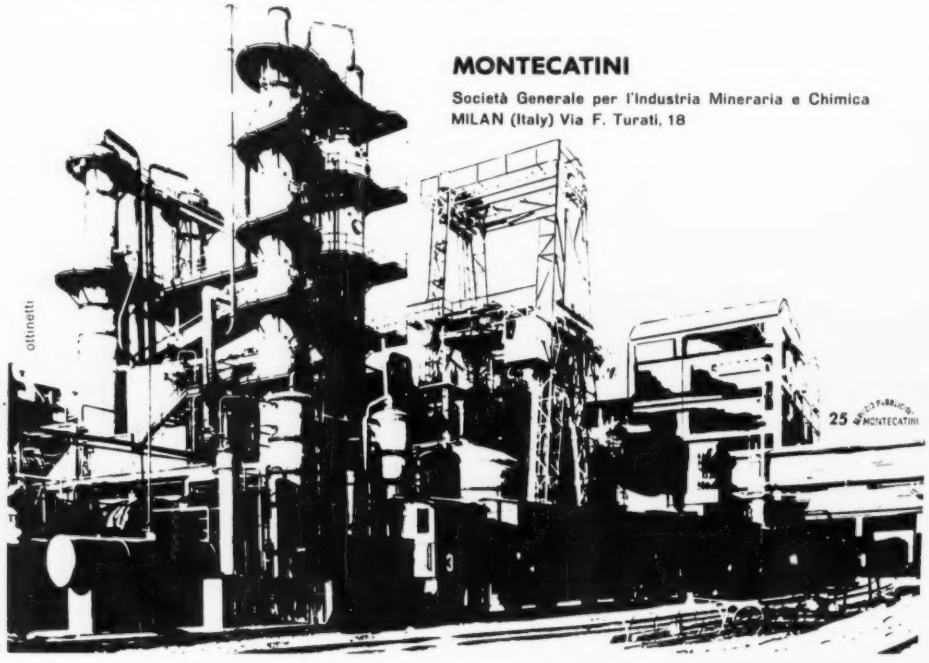

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Ammonium Sulphate Today -
The World Picture

COKE-OVEN and synthetic ammonium sulphate producers have been concerned at the decline in the consumption of ammonium sulphate in mixed fertilizers for some five years past, but events in the fertilizer industry recently have emphasised even more strongly the present unhappy position of this nitrogen product which, although it is still the largest single nitrogen fertilizer used, in the last seven years or so appears to have been relegated to third-place of importance regards rate of growth among suppliers to fertilizer industry.

Annual production capacity in world nitrogen is over 12 million tons of nitrogen, of which some 81% comes from 350 synthetic plants and the balance from coke-ovens. Of world consumption about 83% goes to fertilizer and 17% is used for industrial purposes. Of some 2.9 million tons N produced as ammonium sulphate, that produced as by-product amounts to about 500,000 tons N and that produced from gypsum, which until recently has had an edge of sulphate produced by other means, to a similar total. The countries using the gypsum route are United Kingdom (160,000 tons N*), India (86,000 tons N*), Pakistan (30,000 tons N*) and East Germany (300,000 tons N*).

Low-cost Nitrogen

Fertilizer manufacturers have always used the lowest cost nitrogen material in preparation of mixed fertilizers. Nitrogen for this type of fertilizer was first obtained from natural organics, but was later replaced by lower cost nitrogen in the form of sodium nitrate from Chile. This in turn was replaced by still lower cost nitrogen in the form of ammonium sulphate. From 1929 onwards, however, the sulphate began to be replaced in mixed fertilizers by an even cheaper form of nitrogen —ammoniating solutions. These have been constantly improved to replace more and more ammonium sulphate, while improved technological processing has also had a marked effect.

It was after the World War I that ammonium sulphate became a serious competitor to Chilean sodium nitrate which during the previous century and right up to the 1920's accounted for almost all nitrogen fertilizer exports. By 1928 ammonium sulphate accounted for 36% of nitrogen fertilizer exports, and since World War II had increased its share of total exports. In the last three years, however, exports of ammonium nitrate and urea have been gaining ground.

Striking Progress of Urea

Of the nitrogenous fertilizer materials striking progress has been made by urea—production and consumption rising in 1958-59 by 23.5% and 31% to 667,000 tonnes N and 687,000 tonnes N respectively. World urea capacity also increased by about 580,000 tonnes (262,000 tonnes N), with Japan accounting for almost one-half. Yet the most important advance has been made by ammonium sulphate. World output rose to 2,855,000 tons in 1959-60 from 2,690,000 tonnes in the previous year. Contributing to this rise has been the greater production in Western Europe where production has risen by about 6% to 1,200,000 tonnes N. Even in the U.S.A. ammonium sulphate production rose slightly from 330,000 tonnes N in 1958-59 to 350,000 tons in 1959-60.

The Western Europe output of ammonium nitrates and in particular lime (calcium) ammonium nitrate, has advanced (i.e. calcium nitrate by 4½% and 5¼%) to 385,000 tonnes N and 381,000 tons N in 1957-58 and 1958-59 respectively. World production of ammonium has increased from 2,845,000 tonnes N to 3,079,000 tonnes N for the years 1958-59 and 1959-60 respectively.

*Estimated.

During World War II, when all forms of nitrogen became scarce, substitution of ammoniating solutions for ammonium sulphate was halted and at the war end the general scarcity of all forms of nitrogen caused coke-oven plants to increase their production of sulphate, even by purchasing anhydrous ammonia. Demands for fertilizer materials from overseas gave the impetus to synthetic ammonia plants to start making sulphate as well and after the war coke-oven producers improved their product so that it was suitable for use as the top and side dressing market, and thus provided for a substantial tonnage outlet which had been replaced in mixed fertilizer by ammoniating solutions. In the U.S.A. both by-product and true synthetic producers of sulphate competed for this market and hence, with increased production, a surplus of sulphate now remains for disposal in export market.

Challenge of Ammonium Nitrate

Although ammonium sulphate is still consumed in greater quantities than any other nitrogenous materials, ammonium nitrate is challenging it strongly. Together these two fertilizer products account for over 50% of world consumption. But now accounting for nearly 10% of total nitrogen consumed in U.S. agriculture is ammonia applied directly to the soil in the form of anhydrous or ammonia liquor. In the United Kingdom many of the gas works are selling their ammonia liquor either as it is or in a more concentrated form for direct application to the land. Assisting this trend has been the rapid development in suitable agricultural machinery for applying the ammonia liquor.

In Western Europe and the United States ammonium nitrates are now the principal nitrogenous fertilizer, with ammonium sulphate being preferred in the Middle and Far East, mainly due to Japan's large production of it. Rapidly gaining over sulphate even in this market are ammonium nitrate and urea, and Japan, to meet the competition, is now increasing its urea production at the expense of sulphate.

Affecting the U.S. ammonium sulphate exports to-day is the domestic production of such countries as Canada, India and Korea. Canada as yet uses relatively small quantities of chemical fertilizers. Annual consumption in Canada does not exceed 50,000 tons of nitrogen although production is of the order of 200,000 tons a year—mostly synthetic. This surplus goes for export, in particular to the U.S.A.'s West Coast. In India and Korea, which previously imported all their requirements of nitrogen, some synthetic nitrogen plants are now in operation and more are due on stream within the next three years. Their potential needs and those of China, however, are astronomical. Competing strongly with the U.S.A. and Japan in the export field is Western Europe.

Western Europe as Exporter

United Kingdom

Nitrogen fertilizer exports from the United Kingdom have been mostly as ammonium sulphate. Markets receiving this fertilizer material have been mainly the Commonwealth countries, which in 1959 received 82% of U.K. production. This pattern however, is changing with the growing domestic production in India, Pakistan, South Africa and the West Indies.

In the U.K. the greater part of ammonium sulphate is produced synthetically, mainly by Imperial Chemical Industries Ltd. at Billingham.

U.K. Ammonium Sulphate Production
(Tons)

	1959	1958	1957
By-product ammonium sulphate	282,500	310,200	334,800
Synthetic ammonium sulphate	906,700	879,700	849,300

As this table shows, synthetic ammonium sulphate production has risen while by-product material has been falling, due to the closure of gas works and the growth of direct sale of works ammonia liquor for fertilizer application. Production of concentrated ammonia liquor from by-product liquor calculated as 25% strength has been 113,600 tons in 1957, 116,900 tons in 1958 and 114,200 tons in 1959. Some of this concentrated liquor produced was converted to ammonium sulphate included in the ammonium sulphate table above.

Belgium

Ammonium sulphate has been the main nitrogen fertilizer exported by Belgium since the early 1930's, but in recent years more ammonium nitrates and ammonium phosphates have been exported, while urea exports are becoming increasingly important. Over half of Belgium's fertilizer exports go to Asia with China as a major importer. Yet, Belgium, although favouring urea and ammonium nitrates, has continued to increase ammonium sulphate production.

West Germany

During World War I large synthetic ammonium sulphate plants were set up in Germany, in particular at Merseburg (Leuna) and Oppau. Main producers to-day are Badische Anilin - und Soda - Fabrik AG., Farbwerke Hoechst AG. and the Ruhr producers co-ordinated by Ruhrstickstoff AG. Ammonium sulphate has normally formed a high proportion of Germany's nitrogen exports, and accounts for over one-half of the total. Before World War II Germany's main export market was Europe, but to-day, Asia is the major market with Africa, and Central and South America taking increasing amounts. Ammonium sulphate goes to Europe together with lime ammonium nitrate. (The latter fertilizer is favoured in Asia also.)

Ammonium sulphate output has continued to rise and in the fertilizer year 1959-60 totalled 245,000 tonnes N as against 233,000 tonnes N in 1958-59. Supplies of ammonium nitrates and urea have also continued to increase.

Netherlands

Since the early 1930's, the Netherlands has been an important exporter of fertilizer nitrogen, and almost all the ammonium sulphate manufactured is sold for export. The level of ammonium sulphate exports has not shown any great rise since 1952 although in this same period lime ammonium nitrate exports have doubled. The greater part of nitrogen fertilizer exports to Europe and Asia are in the form of ammonium sulphate, while the other main market, North America, takes mainly lime ammonium nitrate. Central and South America and Africa take ammonium sulphate, but Netherlands urea exports are increasing rapidly.

Italy

Prior to World War II Italy mainly exported ammonium sulphate but this fertilizer now accounts for less than half the country's exports being displaced by urea and ammonium nitrates. Italy's production of ammonium sulphate reached 240,000 tonnes N in 1958-60 as against 227,000 tonnes N in 1958-59. Last year, however A.N.I.C. at Ravenna brought into production their ammonium sulphate installations.

Output of ammonium nitrates and urea has also risen, that of the former being more spectacular. In 1956-57, 75,000 tonnes N of ammonium nitrates was produced—in the last fertilizer year (1959-60), output was 158,000 tonnes N.

Asia takes about half of Italy's nitrogenous fertilizer exports in the proportion ammonium sulphate 50%, ammonium nitrate 25% and urea 25%. In Europe, Greece and Yugoslavia are Italy's main export markets.

Portugal

In Portugal, as yet, only a producer and importer of ammonium sulphate, domestic output of ammonium sulphate has steadily increased since 1954 and in 1959 totalled 37,900 tonnes N. Ammoniaco Portugues SARL are now carrying out expansion plans which will increase their ammonium sulphate capacity to 33,000 tonnes N a year. Ammonium nitrate and urea will also be produced—up to 13,000 tonnes N and 10,000 tonnes N respectively.

Uniao Fabril do Azoto of Lisbon have also a urea facility under way at Barreiro (40,000 tonnes N a year). The other main Portuguese producer, Nitratos de Portugal, has a new works under construction which will have as principal end-products lime ammonium nitrate (20,000 tonnes N) and ammonium phosphate or nitrophosphate.

The main nitrogenous fertilizer imported by Spain is ammonium sulphate (71,984 tonnes in 1959), the greater part being supplied by West Germany (37,507 tonnes in 1959) followed by Belgium and Luxembourg (22,383 tonnes).

Imports of ammonium nitrates, however, showed a sudden rise last year to 10,603 tons compared with 3,771 tonnes in 1958. With her Second Five-Year Plan under way, Portugal can expect to become an exporter of nitrogenous fertilizer products herself.

United States

Of the producers of ammonium sulphate, the synthetic producers are the least concerned for they can cease production of sulphate at will and change over to production of other nitrogen-containing products. The U.S. synthetic sulphate industry is geared to demands, particularly from overseas markets. Any falling off in exports, therefore, means a reduction in synthetic sulphate output. The position is even more difficult for the coke-oven producers of sulphate whose output is a by-product of steel manufacture or gas manufacture. More steel and gas produced means more ammonium sulphate, and any reduction in outputs of these means less coke-oven sulphate production. In U.S., with the setback in steel production, the situation has become critical. Thus although output has been running substantially below that of early 1959—about 139.4 million lb. in March this year (a 4.7% increase over the February output), compared with 147.5 million in March 1959, sales were down to about 124.6 million lb. in March as against 199.3 million in the same month last year.

A combination of factors is listed by U.S. coke-oven producers—increased production of sulphate from other sources; weaker fertilizer demand; and, change to other forms of nitrogen by fertilizer mixers.

Affecting production by U.S. coke-oven and synthetic producers are not only new

Fertilizer Production in Major Exporting Countries ('000 in tons N)

Country	Material	1955/56	1956/57	1957/58	1958/59	1959/60
U.S.A.	Ammonium sulphate	380	355	345	330	350
	Ammonium nitrates	800	850	880	850	900
	Urea	180	210	230	245	280
	Other	673	644	674	1,002	1,150
Canada	Ammonium sulphate	46	60	70	64	85
	Ammonium nitrates	70	65	75	95	110
	Urea	—	—	—	3	28
	Other	70	67	65	67	71
Japan	Ammonium sulphate	448	501	538	579	570
	Ammonium nitrates	12	7	8	9	10
	Urea	83	130	168	242	260
	Other	118	142	169	162	163
W. Germany	Ammonium sulphate	165	180	223	233	245
	Ammonium nitrates	397	396	480	454	480
	Urea	7	45	43	49	55
	Other	183	274	296	314	320
Netherlands	Ammonium sulphate	82	85	76	76	80
	Ammonium nitrates	172	183	224	237	245
	Urea	10	18	18	30	42
	Other	18	43	62	51	55
Belgium	Ammonium sulphate	125	124	129	162	168
	Ammonium nitrates	86	94	108	112	119
	Urea	—	—	—	—	30
	Other	15	8	8	22	24
Italy	Ammonium sulphate	157	155	162	227	240
	Ammonium nitrates	58	75	101	142	158
	Urea	19	29	31	40	50
	Other	109	107	127	133	137
*Other Countries	Ammonium sulphate	797	857	949	1,018	1,117
	Ammonium nitrates	408	705	830	946	1,057
	Urea	3	4	39	52	82
	Other	764	802	776	849	884
*TOTAL	**Ammonium sulphate**	**2,200**	**2,317**	**2,492**	**2,690**	**2,885**
	Ammonium nitrates	**2,005**	**2,375**	**2,706**	**2,845**	**3,079**
	Urea	**302**	**446**	**529**	**661**	**827**
	Other	**1,950**	**2,087**	**2,192**	**2,600**	**2,804**

* Excluding U.S.S.R.

N.B.: Ammonium nitrates include lime ammonium nitrate and ammonium sulphate nitrate.

plants but new technologies. Ammonia solutions are available in ample supply and have been constantly improved and in 1956 it was reported that more and better nitrogen-containing solutions were being used to replace more ammonium sulphate.

The situation has now become critical in the U.S. as greater production of mixed fertilizers has resulted in replacement of more sulphate.

As far as can be judged there is at present no serious oversupply but coke-oven industry spokesmen admit that there is probably more available than the market can take up.

In the U.S. production of ammonium sulphate from coke-ovens in 1959 was 620,000 tons, this low production being due to the steel strike. The sulphate was manufactured from by-product coke-oven ammonia and purchased sulphuric acid. Production of synthetic ammonia sulphate in the same year totalled 1.1 million tons, most of it produced from by-product sulphuric acid and synthetic ammonia, either purchased or captive.

True synthetic producers of ammonium sulphate in the U.S. are those East of the Rocky Mountains and include Philips Chemical Company at Houston, Texas, and Northern Chemical Industries at Searsport, Maine. On the West Coast there is also some true synthetic production.

Some synthetic producers have ceased production of true synthetic ammonium sulphate due, it is believed, to competition from the by-product production. Such companies include Olin Mathieson at Pasadena, Texas, and Baltimore, Maryland, Monsanto Chemical at Eldorado, Arkansas and Best Fertilizer Company at Houston, Texas. These companies can if they wish resume production if demand calls for it. Synthetic sulphate is also produced in Puerto Rico by W. R. Grace & Company, and results in reduced imports from continental United States.

The present total production of ammonium sulphate in the U.S. at 1,620,000 tons is greater than present domestic consumption and stocks at the end of April 1960 were over 150,000 tons in the previous months, compared with 118,000 tons a year ago. With production down because of the steel strike, stocks should of course be much lower. Over the last few years, North America, and the U.S. in particular, has become an important exporter of ammonium sulphate but exporting the surplus by-product sulphate plus true synthetic sulphate is fast becoming more and more difficult because of the growing preference for ammonium nitrate and urea. Also the synthetic sulphate has an edge on the coke-oven by-product since it is favoured by importers because of its white colour and free-flowing characteristics due to the larger crystal size.

If the effect of substitution of ammonium sulphate in mixed fertilizer 5-10-10 (which represents approximately 10% of U.S. tonnage of mixed fertilizers annually) is considered, it is seen that one ton of 5-10-10 contains 100lb. of nitrogen. If this nitrogen is obtained from ammonium sulphate, 500lb. of this compound is required. If all the nitrogen is obtained from ammoniating solutions, and since 1,500,000 tons of 5 to 10% are used a year, ammoniating solutions have replaced almost 375,000 tons in this one grade of fertilizer.

It is only since 1956 that the United States has become a net exporter of fertilizer nitrogen. Before World War II ammonium sulphate was the main nitrogen fertilizer export product, but by 1948 ammonium nitrate exports represented one-half of total production as against one-third for ammonium sulphate. At present over 40% of ammonium sulphate produced in the U.S. is exported.

Japan

Ranking as second largest exporter of nitrogenous fertilizers after the U.S. is Japan. Up to 1955 90% of Japan's nitrogen fertilizer exports were in the form of ammonium sulphate. Last year this fertilizer accounted for 60%, but fast encroaching is urea, which since 1955-56 has risen from 8,300 tons N to 260,000 tons N in 1959/60.

Japan's ammonium sulphate production for 1959-60 shows a slight fall from 579,000 tons N in the previous fertilizer year — a peak year — to 570,000 tons N. Ammonium nitrates have shown no appreciable rise—10,000 tonnes N in 1959-60 compared with 9,000 tonnes in 1958-59.

Consideration has been given to closure of several of the older and less efficient ammonium sulphate works, and the bulk of ammonia capacity coming on stream in 1959 has been devoted to urea manufacture. The greater production of urea is to give the Japanese an edge on the nitrogen fertilizer export market.

Canada

Currently Canada has been improving its nitrogen fertilizer industry. During 1959, Cyanamid of Canada Ltd. brought into operation their urea plant at Hamilton, Ontario. At Fort Saskatchewan, Alberta, however, Sherritt Gordon Mines Ltd. have announced that capacity at their ammonium sulphate recovery works is to be doubled, while Brockville Chemicals Ltd. are to enter the ammonium sulphate manufacturing field with a 60,000 tonnes N-a-year plant at Maitland, Ontario.

In 1959-60 Canadian production of ammonium sulphate amounted to 85,000 tons N. Urea production began in 1958-59 with some 3,000 tonnes N. In 1959-60 this had risen to 28,000 tonnes N, due to the Cyanamid urea plant coming on stream.

India

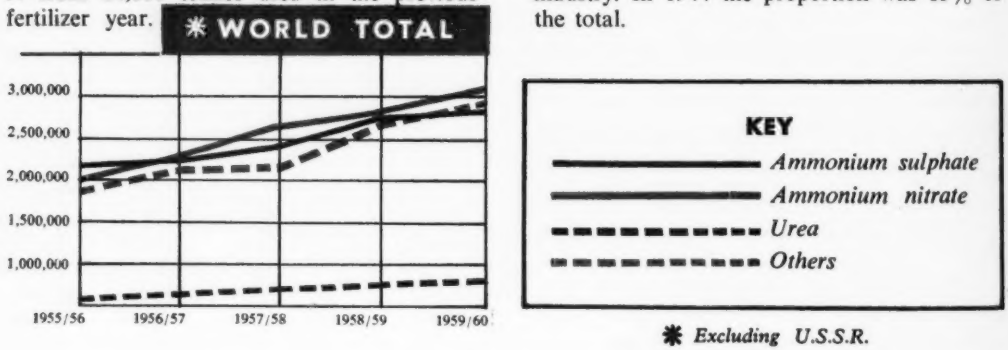
It is a notable feature that in India ammonium sulphate has gained at the expense of ammonium nitrates, the former advancing by 39,000 tonnes N to 138,000 tons N in 1958-59, while the latter fell to 9,000 tonnes N from 24,000 tonnes used in the previous fertilizer year.

Outlook

In assessing the competition for ammonium sulphate, the two recently introduced nitrogenous fertilizers, urea and diammonium phosphate must be given serious consideration. Seen as likely to gain greater importance in the U.S., the U.K. and certain West European countries, are ammonia liquor, ammonium nitrate and nitrogen solutions, the trend being towards high nitrogen analysis materials.

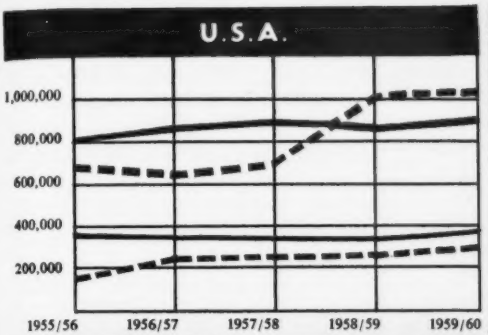
Affecting the position of ammonium sulphate in the U.S. and the U.K. also is the revolution in fertilizer manufacturing techniques as instanced by granulation and ammoniation which has to some extent caused the sulphate to fall from its dominant position in mixed fertilizers and in application techniques which permit application of liquid nitrogen fertilizers.

Rising demand for high analysis fertilizers favours nitrogen materials of high concentrations, while the relative cost per unit of nitrogen is important. Sulphate of ammonia contains only 20.56 to 21% N, even at the current low ton cost, and this is somewhat higher than the unit cost of nitrogen in ammoniating solutions or in anhydrous ammonia. Total ammonium sulphate usage in mixed fertilizers in the U.S. is noted as having dropped 10% in the decade starting 1946/47. In 1954 U.S. use of ammonium sulphate as fertilizer totalled 1.4 million tons, of which 67% was utilized by the mixed fertilizer industry. In 1944 the proportion was 83% of the total.



* *Excluding U.S.S.R.*

N.B. *Ammonium nitrates include lime ammonium nitrate and ammonium sulphate nitrate.*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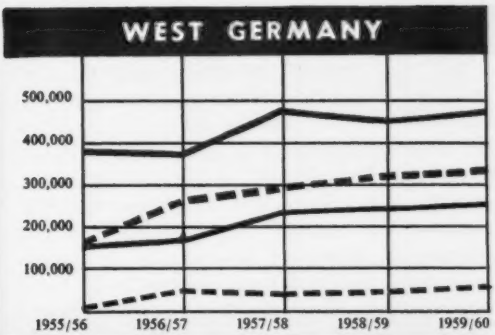
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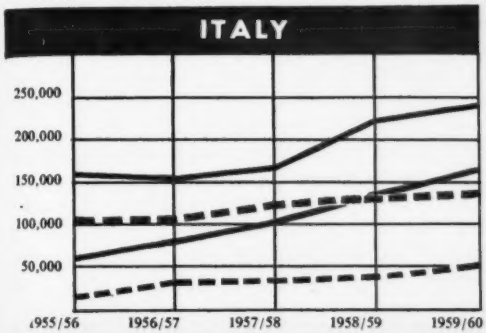
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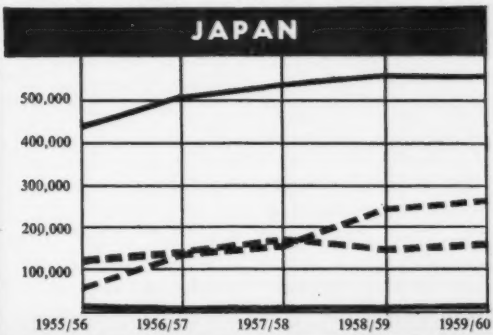
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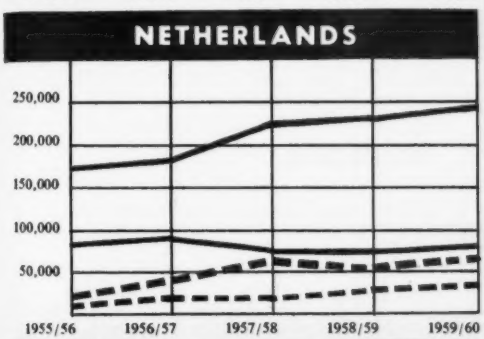
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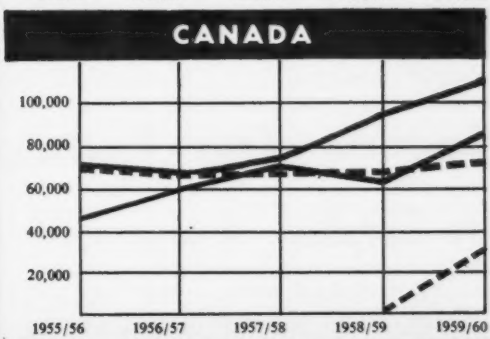
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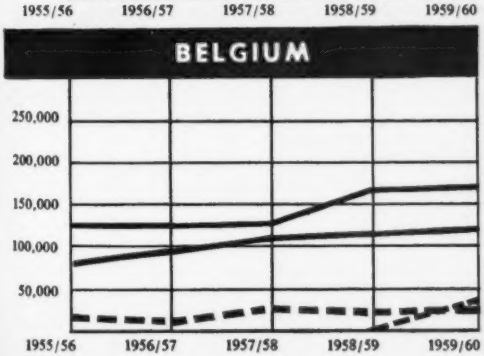
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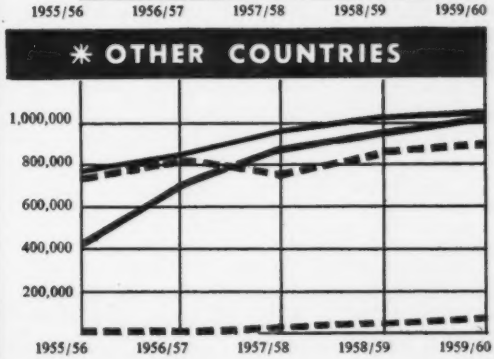
* OTHER COUNTRIES
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The question now present in all coke-oven and synthetic ammonium sulphate producers' minds is, whether ammonium sulphate can maintain its present tonnage and perhaps even increase this in the next decade.

The manufacturer of dry mixtures, faced with stiff competition, will use only the quantity of ammonium sulphate that he believes is essential. If the sulphate is economical, he would use more as it is easy to handle and provides his mix with free-flowing, non-caking and good storage qualities. These properties and others such as the high sulphur content, now becoming better recognized as an essential in good fertilizer techniques, and the improved properties it provides in granulating fertilizers are all advantages which could be exploited. U.S. spokesmen feel that ammonium sulphate, if aggressively exploited, could not only maintain its present production and consumption, but even gain during the next few years. To accomplish this, however, the sulphate would have to make greater inroads into the bulk-blend market and in direct application tonnage.

The overall picture is that at present ammonium sulphate is showing a lower growth rate than ammonium nitrates or urea. Also, that despite the concern of U.S. producers, outside the U.S. and the Netherlands ammonium sulphate is holding its position. A factor affecting the U.S. picture and which could be influencing that of the Netherlands, is the high cost of sulphuric acid, and in the case of the U.S. transport and freight costs. Japan, as the second largest producer, has a geographical advantage in selling sulphate to the Middle and Far East, which countries prefer ammonium sulphate. As urea is also a suitable fertilizer for these areas Japan is naturally seizing upon the opportunity to enter a field where the competition is very much less at the present time.

Therefore, despite the problems affecting the ammonium sulphate industry, in the U.S. and Japan in particular, this fertilizer material can be expected to continue to play an important part in the nitrogen fertilizer industry. A factor very much in favour of the sulphate industry is that a comparatively stable supply/demand balance can be maintained.

We are indebted to Chester S. Edwards for comments on the world picture and the U.S. ammonium sulphate picture. See also following article.

American Coke-Producers' Concern at Surplus Ammonium Sulphate

STRONG opposition from other nitrogen products and improved techniques in the production of mixed fertilizers has resulted in ammonium sulphate losing its previous position of importance in fertilizer markets. In particular, the situation is becoming somewhat critical in the United States. Having regard to the prolonged steel strike in the U.S. last year and the present low level of operations a dearth of ammonium sulphate could be expected with stocks at a low level. The most recent Bureau of Mines report (27 April 1960) shows stocks of coke-oven ammonium sulphate to be over 150,000 tons at 31 March 1960, compared with 118,000 tons a year ago.

Discussing the competitive position of coke-oven ammonium sulphate recently, president of Nitrogen Products Inc., Chester, S. Edwards, reviewed the present situation and suggested possible ways of overcoming the surplus of this nitrogen product that is concerning U.S. coke-producers.

To place the situation in perspective, Edwards has reviewed the world picture, since North America has emerged as a net exporting area, with exports exceeding imports.

World nitrogen industry represents an investment of $3,000 million (£1,000 million) with an annual production capacity of over 12 million tons N, of which about 81% is

obtained from 350 synthetic production plants and the balance from coke-ovens. Of world consumption, about 83% goes to fertilizer and 17% is used for industrial purposes.

Position of Ammonium Sulphate

Ammonium sulphate is still consumed in greater quantities than any other nitrogenous material, but making a strong bid for a leading place is ammonium nitrate. Together these two nitrogenous compounds account for over 50% of world consumption. Ammonium nitrate, however, is now the principle nitrogenous fertilizer used in Western Europe and the U.S. with ammonium sulphate the preferred fertilizer material in the Middle and Far East. Even in this market, ammonium nitrate and urea are rapidly advancing at the expense of the sulphate.

Greater use of nitrogen has resulted from the adoption of the cheaper fertilizer materials, such as anhydrous ammonia and ammonia liquor applied directly to farmland. Contributing to the fast growing production of liquid fertilizers are the improvements in agricultural machinery. Consumption of urea is also rapidly increasing in North America, both as a fertilizer material and as an animal feed. Japan, too, is increasing its production of urea, again at the expense of sulphate.

Coke-oven Sulphate

Coke-ovens in the U.S. are situated mainly in the area east of the Rocky Mountains. According to the Bureau of Mines production of sulphate from coke-ovens for 1959 amounted to 620,000 tons, this low production being due to the steel strike. This sulphate was produced from by-product sulphuric acid. Synthetic ammonium sulphate, the U.S. Department of Commerce reports, in 1959 was 1.1 million tons. Most of it is produced from by-product sulphuric acid and synthetic ammonia, either purchased or captive and, as Edwards points out, is as much a by-product as is coke-oven sulphate. In one case, the ammonia is the by-product and in the other the acid is the by-product. Hence the by-product coke-oven production of sulphate added to the by-product synthetic production gives an estimated total production of by-product sulphate of 14.2 million tons which is greater than present U.S. domestic consumption.

Producers of true synthetic sulphate remaining east of the Rockies are Phillips Chemical at Houston, Texas, and Northern Chemical Industries at Searsport, Maine, and there is also some true synthetic production on the West Coast. Former true synthetic producers — Olin Mathieson, Pasadena, Texas and Baltimore, Maryland; Monsanto Chemical at Eldorado, Arkansas and Best Fertilizer Co. at Houston, Texas, have discontinued making true synthetic sulphate, Edwards notes. They could resume production, however, if demand should require it.*

Finding the answer

Exporting the surplus by-product sulphate plus the true syntheic sulphate is becoming more difficult for U.S. coke-oven producers, for the reasons already noted above (i.e. growth in use of ammonium nitrate and urea) and is not the answer to the problem. Export sales of coke-oven sulphate at the present time are not even returning the U.S. producers' costs of sulphuric acid, because of high freight rates to reach ports. Edwards says there is a real need to find better domestic outlets, and suggests that some producers should seriously consider making ammonia liquor instead of sulphate. Encouraging such a move is the increasing interest in use of ammonia liquors as fertilizers and also earnings which Edwards calculates as favouring liquor over solid ammonium sulphate. Thus; one ton of ammonia produces four tons of sulphate. A ton of sulphate (25% NH_3) sells for $32 or $128 for four tons. From this $80 is subtracted as the cost of four tons of sulphuric acid required to make it. This leaves a coke-oven producer a maximum of only $48 before freight equalization, for a ton of ammonia in the form of ammonium sulphate. If $5 freight equalization is taken up by each ton of sulphate making $20 on the four tons, the return is

* American Cynamid's Fortier plant, located at New Orleans, has been and is now producing true synthetic ammonium sulphate from virgin sulphuric acid and ammonia.

reduced from $48 to $28. (In these figures, no consideration has been given to depreciation, costs of labour, handling, shipping, etc.

Advantages

Besides a better return per ton of ammonia in the form of 30% liquor, Edwards sees additional advantages such as elimination of purchasing and using sulphuric acid, production of more concenrated nitrogen product than a solid and lower cost of storing liquor in a sulphate, greater ease in handling a liquid over tank.

Recovery of Anhydrous Ammonia from Coke-oven Gas

Inland Steel Co's. New Process

CONVERSION of a sulphate plant to ammonia liquor production was not discussed by Edwards, but a new processing technique for recovering anhydrous ammonia from coke-oven gas has been described by M.O. Holowaty and H.L. Taylor of Inland Steel Co., East Chicago, Indiana. The process opens up the possibilities of coke-oven plants, now producing ammonium sulphate as by-product, competing more favourably with synthetic nitrogen products. Proved on a pilot-plant the key to Inland Steel's process is an ammonium bisulphate solution that can be regenerated and recycled.

Cooled raw gas from the coke-ovens is passed through a conventional absorption tower. The rising gas is washed with a descending saturated solution of ammonium sulphate containing 8% ammonium bisulphate. Ammonia in the gases is absorbed, and reacts with the ammonium bisulphate to form ammonium sulphate and water. As the solution is saturated with ammonium sulphate, any additional product that forms in the reaction will precipitate.

Ammonium sulphate precipitate leaving the bottom of the tower is separated by decantation, dried on draining tables and in centrifugal dryers. From these the sulphate is transferred to a decomposition chamber and heated to 650°F when it decomposes into ammonia gas and molten ammonium bisulphate. The ammonia is passed through gas-cleaning equipment, dried and compressed. The molten ammonium bisulphate is returned to the solution passing to the top of the absorber.

Value of the process

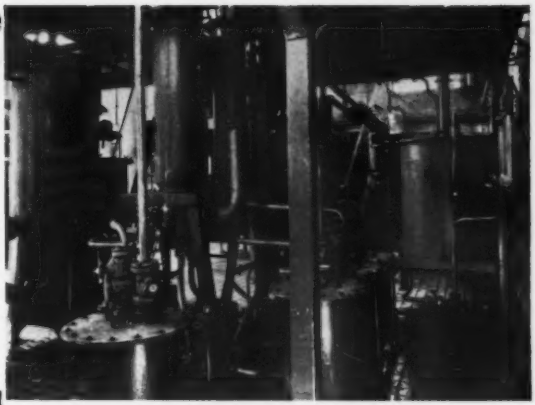
Several advantages of this process can be listed:—

- No net consumption of sulphuric acid. In conventional gas-oven plants use of acid is 40-60% of total manufacturing costs, depending on the size of plant.
- Use of existing plant. With the exception of ammonia dryers, compressors and decomposition chamber all equipment for making anhydrous ammonia is common to existing plants that produce ammonium sulphate by sulphuric acid absorption.
- Flexibility. Plant designed to produce anhydrous ammonia can be changed over to ammonium sulphate production by shutting down the decomposition chamber and ammonia section, and by adding sulphuric acid instead of ammonium bisulphate to the solution passing to the absorber. Facilities for handling precipitated ammonium sulphate remain the same for both processes.

The only specialised equipment required is the decomposition reactor, which is of silicon-oil-coated graphite placed in a shell cast from a high alumina refractory; this latter has electrical resistance heaters cast into its walls.

Ammonium Sulphate Manufacture Without the Use of Sulphuric Acid

Advantages of the Piritas Españolas Process



Part of the ammonium sulphate manufacturing plant of Piritas Españolas

AMMONIUM sulphate is to-day produced on a commercial scale generally by combination of ammonia with sulphuric acid. Manufacture of sulphuric acid necessitates the supply of sulphur dioxide gas of adequate concentration and of a high decree of purity and its oxidation generally by means of a special catalyst. The development by Piritas Españolas, Madrid, Spain, of a process whereby the intermediate production of sulphuric acid is unnecessary, and hence the catalytic oxidation of SO_2 to SO_3 during the gaseous phase can be avoided, together with thorough cleaning of the sulphurous gases, must be deemed both interesting and important. In the process developed oxidation is substituted by a reaction which is not a catalytic one and which takes place during the liquid phase. It is also much simpler to bring about, as the heat exchange is much easier and less care is needed in the cleaning of the gases. The operation, in fact, is reduced to de-dusting and simultaneous heat conditioning of the gases.

Economically attractive

Economically the Piritas Españolas process is attractive both for the simplicity of its installations and for the reduced operating costs. Also it appears to permit production of ammonium sulphate fertilizer at an extremely low price, which would be difficult, if not impossible, to improve upon.

The process consists of absorbing sulphurous gases in a basic organic solvent. The solvent, enriched with basic sulphide, is oxidised by injecting air whereby a basic sulphate is formed and the organic solvent is freed and recycled to the circuit for further use. As such the process compares advantageously with the production of sulphurous gases obtained by roasting pyrites of concentrations of between 7 and 15% SO_2. The advantage is seen to be very much greater when recovery of SO_2 from lean smelter flue gases is considered since the low SO_2 content (2% to 4%) makes it difficult to use them economically while their removal to prevent atmospheric pollution has become essential from a social viewpoint.

The Process

The SO_2 gases, whatever their origin, enter a packed absorption column where they come in contact with the basic organic solvent — xylidene, pyridic bases from coal tar, monomethylaniline, quinoline, etc., either used singly or as a mixture. The solvent mixture which flows from the bottom of the column, contains the SO_2 in the form of basic sulphite, and is passed to the oxidation reactors (Flow sheet — 2 and 3) where air is blown through by means of a compressor. The temperature tends to rise and this tendency is counteracted by means of cooling coils submersed in the solvent - SO_2 mixture. Some of the cooled liquid (heat exchanger 4) which is partially oxidised is recirculated to the absorption column to control the temperature, and to ensure that the packing is adequately melted. That part of the liquid which is not recirculated is completely oxidised in the reactor (3) and is passed to the saturator where it is reacted with ammonia.

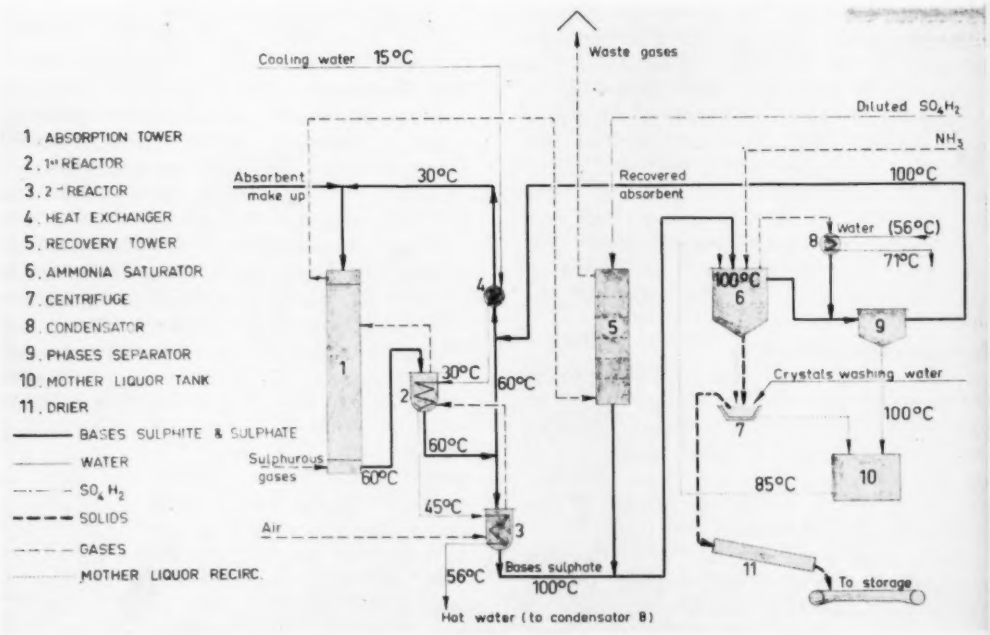
The saturator employed is a conventional one and retains a constant charge of a saturated solution of ammonium sulphate. The organic base sulphate and the ammonia are reacted, when the organic base is freed and rises to the reactor (it does not mix with the saturated ammonium sulphate solution). The solution is allowed to settle (9), when the lighter organic solution overflows and any ammonium sulphate taken over with it is collected in vessel (10). From vessel 9, recovered solvent is recirculated to (1), through the heat exchanger (4) to which is added fresh make-up organic solvent. The crystalline ammonium sulphate is discharged into a continuous centrifuge, the solid salt is separated and passes to the dryer. The "mother liquid" passes to vessel 10 and recirculated. The required heat for drying the ammonium sulphate is obtained by using the heat of the water coming from heat exchanger (8).

The reaction between the organic base sulphate and ammonia is a strongly exothermic one, and the heat evolved is absorbed by the water and organic solvent contained in reactor (6). Steam generated is condensed in heat exchanger (8) and the condensate is drawn off to vessel 9, where organic solvent is separated from the water.

Residual gases from the SO_2 absorption column (1) are passed to the tower (5) where by contact with dilute sulphuric acid, the organic material as mist is recovered and transformed into base sulphate. The small amount of sulphate formed joins the main stream passing to the reactor (6) to be decomposed with ammonia.

The same water circuit can be used for the reactors, heat exchangers (4, 2, 3 and 8) and also for the dryer. Similarly the air for oxidation of the sulphide in (2) and (3) passes through both reactors in series and finally passes to (1) to recover the SO_2 and any solvent carried over.

This same plant can be used whether the gases are from roasting furnaces or from smelter flues. The only difference, for an equal production of ammonium sulphate from the two sources, is the size of the tower (1) and (5). For the more dilute gases, larger absorption towers are required.



Flow Sheet of PE process for ammonium sulphate production

Reduced Operating Costs

With regard to financial aspects, operating costs of the Piritas Españolas process are less than those of the classical method, thereby permitting production of ammonium sulphate at a more than competitive price. The greatest reduction in operating costs, however, is found in the water and steam consumption which in this new process are reduced to a minimum. Power consumption is also lower in the PE process.

A key factor in the process is the good recovery of the organic solvent. Losses have never been found to be more than 0.2kg. of organic base per tonne of sulphate produced. This works out at no more than 6 pesetas per ton (8.4d.) on the cost of production.

Estimate of Fixed Assets

(a) *Using roaster gases:* To gain some idea of the advantages of the PE process over the classical methods, an assessment has been made of the ammonium sulphate plant under the five different operations.

Classic Process	PE Process
(1) Pyrites roasting with or without heat recovery	(1) Pyrites roasting with or without heat recovery
(2) Cleaning and drying of sulphur gases	(2) Conditioning of sulphur gases
(3) Production of sulphuric acid in contact plant	(3) Absorption of SO_2 oxidation in liquid phase
(4) Ammonia plant	(4) Ammonia plant
(5) Neutralization of acid and crystallization, centrifuging drying and storage of sulphate	(5) Double decomposition, recovery of bases and crystallization, centrifuging drying and storage of sulphate

As operations 1 and 4 are identical in the two processes, operations 2, 3 and 5 are considered only.

Operation No. 2

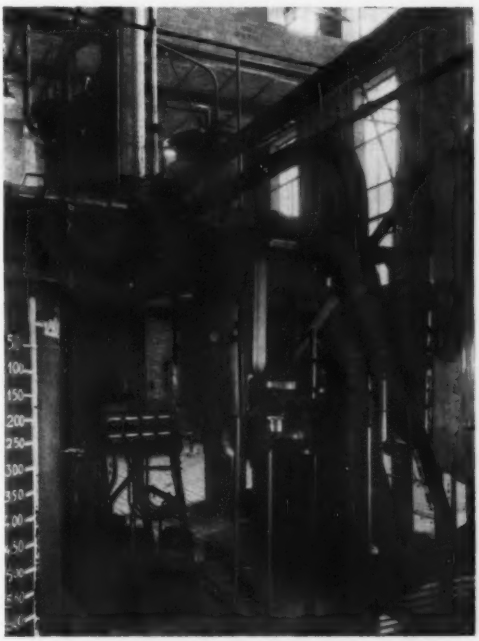
In each case operation No. 2 is made up as follows:—

Classic Process	PE Process
2.1 Peabody washing tower	2. Peabody washing tower
2.2 Electric mist filter	
2.3 and 2.4 Drying tower for air and sulphur gases	

Elimination of 2.2, 2.3 and 2.4 which are indispensable in the classic process for guaranteeing the life of the catlyst and an acceptable conversion return, represent an advantage in favour of the PE process of some 10.6 million pesetas (£63,900 approximately) on the basis of a plant with a capacity of 50,000 tons ammonium sulphate per annum.

Operation No. 3 When the cost of a contact acid plant required in the classical method is compared with the PE absorption and oxidation plant, the latter has a 7.5 million pesetas advantage in lower fixed assets to which must be added the advantage of no sulphuric acid storage of approximately 1,000 cubic metres capacity costing not less than 4 million pesetas.

Operation No. 5 Fixed assets required for both processes are similar. The necessity of installing a separator and one or two supplementary pieces of equipment, brings the PE cost to 1.1 million pesetas more than the cost of the classical method, but the overall



The packed absorption column used in the PE Process

difference is 21 million pesetas in favour of the PE process (see chart).

(b) *With Residual Gases:* As substitution of the PE process in preference to the classical is economically attractive, as far as sulphurous gases from roasting pyrites is concerned its application in the case of smelter gases low in SO_2 is even greater. With pollution laws in force and the necessity of removing SO_2 before emitting exit gases to atmosphere at considerable expense, the PE process is even more attractive. It provides a new approach to the problem of SO_2 removal by absorbing SO_2 and simultaneous oxidation in the liquid phase. The PE process does not require high purity in the inlet gases which can readily be cleaned by means of one or more Peabody scrubbers. The number and cost of the absorption towers depends on the volume of gases and the amount of SO_2 to be treated. The total value of fixed assets can be calculated, however, and on this basis decide the number of absorption units required for the most profitable return of capital.

Installations necessary for the PE process can be divided into three units

(1) Cleaning and conditioning plant for residual gases used.

(2) Plant for absorption, oxidation and recovery of organic bases.

(3) Plant for double decomposition of the organic base sulphate formed, centrifuging, drying and storage plant for ammonium sulphate.

For a plant of 50,000-tons-a-year capacity, the ammonium sulphate plant (see table) is exactly the same as that for gases from roasting furnaces costing some 22 million pesetas (£135,000). The first unit consists of a group of 2, 3 or up to 6 Peabody scrubbers for use with different gas concentrations, namely for 3% for 2% and for 1% SO_2, which cost 68 million (£404,080), 10 million (£59,600), and 19 million pesetas (£117,000) respectively. The second unit, designed specifically for the PE process costs 38 million (£230,000), 60 million (£360,000) or 81 million (£490,000) for the concentrations noted above. Excluding the ammonia plant, the total costs of the plant in millions of pesetas, are as follows:—

Operation	Gases with 3% SO_2	2% SO_2	1% SO_2
(1) Conditioning of Gases ...	6.8	10.0	19.6
(2) Absorption and Oxidation	38.6	60.4	81.2
(3) Ammonium Sulphate ...	22.5	22.4	22.5
Total (millions of pesetas)	**67.9**	**92.9**	**123.3**

Costs vs. returns

Reference to the Chart shows outlay required for the classical and PE processes, and when applied to sulphurous gases from different sources and of different SO_2 content. Calculating on the production cost per ton of ammonium sulphate obtained by the classical and PE processes using plants of equal capacity the costs are compared.

Under the three main headings (1) primary and secondary materials (2) operating costs and (3) interest in fixed capital, it has been ascertained that the PE process is more economical. Most economy is effected by the new process in the operating costs where a reduction of 18.8% is indicated and in the interest on fixed capital, where the reduction is as high as 30.4%.

Taking the fixed assets of an ideal ammonium sulphate plant (see below) as giving an interest of 15% when using the classical process, a reduction of 99 pesetas (approximately 11s.) per ton in operating costs is possible with the PE process, thus resulting in an increase of 4.95 million pesetas (£29,000)

Cost of 1 ton ammonium sulphate by PE and classic installation*

Group	Process Classic	PE	Difference in favour of PE	%
Fixed assets in pesetas (millions)	69	48	21	30.4
Materials				
Primary (SO_2	413	391		
(NH_3	1,471	1,471		
Secondary	21	28		
Total of material ...	**1,905**	**1,890**	**15**	**0.8**
Operating costs	85	69	16	18.8
Interest	224	156	68	30.4
Total production costs ...	**2,214**	**2,115**	**99**	**4.5**
Yield	15%	33%	4.94 million pesetas	22.0%

* Based on capacity of 50,000 tons a year using pyrites roaster gases and anhydrous amonia.

in yearly profits. The yield is estimated at 33% or 2.2 times higher than the hold profit rate. It should be noted in the sum total of the fixed assets, no account has been taken of the important economy effected indirectly by using the PE process, that is, avoidance of capital investment for installation of expensive plant to remove SO_2 from gases prior to voiding tc atmosphere.

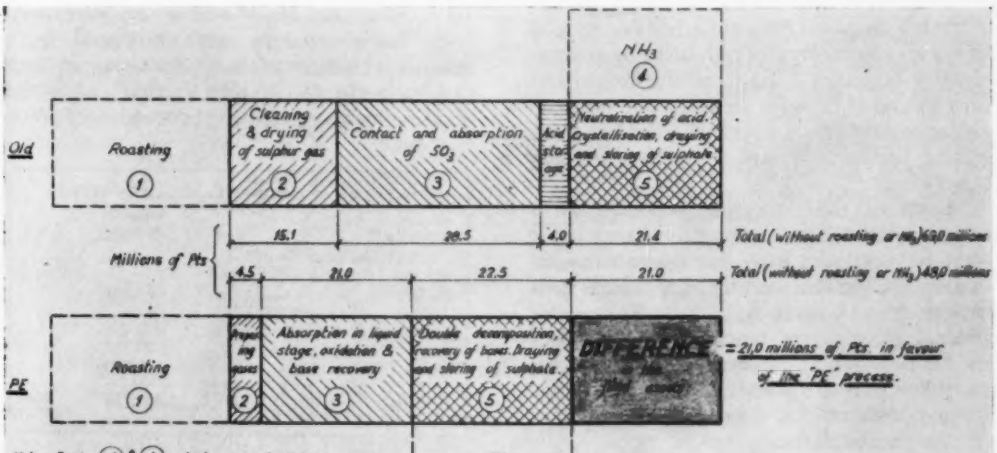
Compared with a yield normally given by an ammonium sulphate plant based on the old system, with a return of 15%, the PE process offers marked advantages for gases containing 3% and 2% SO_2. Such a content brings the yield to 44% and 26% respectively, which represents an increase of 290% and 170% respectively on 15%. Gases having a 1% SO_2 content only just fall within the possibilities of economic exploitation. If the cost of erecting a scrubber, or suitable plant to dilute the gases before these pass to atmosphere, is subtracted from the total cost, then the PE process constitutes a valuable solution, technically and economically, of transforming directly those waste sulphurous gases into a useful and readily marketable product.

Whether it would be possible to use the PE process in the case of gases containing less than 1% SO_2 is not known as yet. Simon-Carves SO_2 gas scrubbing process can be used where SO_2 content is lower than 1%. This process is still being studied however, to ascertain its economic possibilities.

Cost of 1 ton ammonium sulphate and yield from PE process*

Group	Gases from smelter, etc. 3% SO_2	2% SO_2	1% SO_2
Fixed assets pesetas (millions)	67.9	92.9	123.3
Basic materials			
Ammonia ...	1,471,	1,471,	1,471, –
Secondaries ...	54, –	78, –	155, –
Total ...	**1,525, –**	**1,550, –**	**1,626, –**
Operating costs ...	77, –	84, –	105, –
Interest on fixed capital	220, –	302, –	400, –
Total production costs	**1,822, –**	**1,936, –**	**2,131, –**
Lower costs compared with old system ...	392, –	287, –	83, –
Extra annual profit (millions)	19.6	13.9	4.15
Normal profit ...	10.35	10.35	10.35
Total Profit	**29.95**	**24.25**	**14.50**
Yield %	44.1%	26.1%	11.7%

* Based on capacity of 50,000 tons a year using residual gases and anhydrous ammonia.



Comparison of fixed assets required by old system and the PE system

Production and Trade in Complex Fertilizers

A Survey of the Market from the Nitrogen Viewpoint

COMPLEX fertilizers have, during the last few years, established themselves in the world of nitrogen production. This is true both in production and consumption as well as from the trade angle. In 1953-54, the share of this group in world nitrogen production was 13%. Five years later, in 1958-59, it had risen to 15%. Of the world trade in fertilizer nitrogen, complex fertilizers last year had a 5% share; results for the current year indicate no great change in this position.

This survey examines the market for complex fertilizers from the point of view of nitrogen; it is not concerned with the problems of phosphorus and potassium nutrients in this connection. It is intended to show the extent to which the complex fertilizers have become popular with consumers and recent trade in various parts of the world.*

**We are indebted to Dr. G. Sander, Bochum, for the major contribution to this review.*

MAIN reasons for the development of the market in modern complex fertilizers over some of the more traditional kinds of mixed fertilizers are saving in time, labour and storage costs. The background to this market, however, is not easily established statistically. Thus it is almost impossible to establish the world production, consumption and trade of all fertilizer compounds. Even with division of the compound fertilizers into the complex group (that is, fertilizer chemicals chemically combined during production), collection of data about these fails to some extent since not enough is known of the amount of mixing undertaken in various areas or on farms.

That it is difficult to collate data for complex fertilizers is shown by the widely diversified statistical data published on one and the same subject. Figures published by governmental agencies on production and consumption of complex fertilizers are far from satisfactory for many countries, while to date, detailed figures with regard to external trade do not exist.

Some of the difficulties encountered in collecting data for the complex fertilizer market might be mentioned here. For the countries of Western Europe there are reliable official production data available through regular publications, e.g., the reports of the Organisation for Economic European Co-operation. No production data are published by U.S. sources, although data of U.S. consumption by grades and areas are available.

Data differs widely in this most important single market in the complex fertilizer field. In statistics on external trade generally, no clear distinction is made between complex and mixed fertilizers; too often both types of fertilizers are included together under a different heading. Also, in these statistics no indication is given of the nitrogen content — actual or average — of the quantities exported or imported. This survey is therefore based on estimates rather than on definite figures.

Production

World production of complex fertilizers totalled 1,173,000 tonnes N in 1956-1957 and 1,417,000 tonnes in 1958-59 — an increase of 8%. These tonnages were produced in a relatively small number of countries, in fact, mainly in the U.S.A. and Canada and in the classic nitrogen producing countries of West Europe.

Production of Complex Fertilizers in 1958-59

		Tonnes N	%
America ...		915,000	65
North America	899,000		
Latin America	16,000		
Europe		455,941	32
West Europe	443,723		
East Europe	12,218		
Asia		45,817	3
Africa		1,000	
Total ...		**1,417,758**	**100**

Production in North America was 830,000 tonnes N for the U.S.A. and 69,000 tonnes N for Canada. In Latin America, Chile produced 16,000 tonnes.

Europe's most important producer of complex fertilizers is West Germany with a production of 158,900 tonnes N, followed by France (92,200 tonnes), Great Britain (59,000 tonnes), Italy (56,000 tonnes), the Netherlands (31,000 tonnes) and Norway (27,100 tonnes). Belgium, Austria, Sweden and Switzerland in 1958-59 together accounted for 21,500 tonnes N of complex fertilizer production.

In Asia, Japan produced 38,000 tonnes N, Taiwan, more than 3,000 tonnes and the Philippines, 4,800 tonnes. The figure for Africa is wholly accounted for by the production within the Union of South Africa.

Of the countries combined within the Comecon and China, not much is known with regard to their production of complex fertilizers. There does, however, seem to be a growing interest in this group of fertilizers in these countries, judging from the 1958-59 production figure of East Germany (12,218 tonnes N) and plans announced regarding production of complex fertilizers in the U.S.S.R. So far, though, only one pilot plant at Dneprodsershinsk has been reported by Soviet sources.

TRADE

Exports

Of the 18 countries producing complex fertilizers in 1958-59, only ten appear as exporters of this type of fertilizer and only four exported complex fertilizers in sizeable quantities. With world exports amounting to 130,000 tonnes N of complex fertilizers in 1958-59, these four countries had 72% of the total.

Main Exporting Countries of Complex Fertilizers 1958-59

	Tonnes N
Canada	35,500
West Germany	20,400
Netherlands	18,900
U.S.A.	18,500
Total	**93,300**

The remaining six countries were France (12,400 tonnes N) and Chile (9,300), followed by Belgium (6,000), Italy (4,500), Japan (3,800) and Great Britain (600). These totals also show the different degree of popularity of the complex fertilizers within the producing countries. Thus, whereas Canada, for example, exported 51% of her complex fertilizer production in 1958-59 and the Netherlands 61%, the percentage for West Germany was 13% and for France 14%. The percentage for the U.K. for this same year was 1%.

Imports

Complex fertilizer imports for 1958-59 amounted to some 130,000 tonnes N, a rise of 22% over those of 1956-57 when imports were 107,000 tonnes N. Imports for 1958-59 were spread over a great number of countries with individual quantities per country, on the average, not running very high and, excepting the U.S.A., 7,000 to 8,000 tonnesN at the most.

World Imports of Complex Fertilizers 1958-59

		Tonnes N	%
America		79,700	61
North America	34,000		
Central America	30,500		
South America	15,200		
Asia		22,800	17
South East Asia	16,900		
Europe		14,100	11
Africa		12,500	
Australia / Oceania		1,600	1
Total		**130,700**	**100**

In the course of the last few years, some major importing areas for complex fertilizers have emerged, notably Central and South America and South East Asia. These areas are, however, now being challenged by the African countries which lately have been importing increasing amounts of complex fertilizers. This is also true to some extent in the case of Australia/Oceania where three years ago only some 400 tons of complex fertilizers had been imported.

Conclusion

The market for complex fertilizers is expanding and the rising demand for this type of fertilizer is reflected by the growth of production. Ammonium phosphates and ternary complexes based on nitrophosphates combined with potash predominate, and the rapid strides in technique of manufacture of liquid complexes are in evidence. The development by T.V.A.* in the use of superphosphoric acid as a sequestring agent inhibiting the

*Tennessee Valley Authority

dispersion of solid impurities in liquid N.P. complexes based on wet phosphoric opens up a large market for high-analysis liquids. In the field of binaries the development confined to the major potash producing countries of P-K and N-K complexes is advancing.

As yet the advantages of high-analysis complex fertilizers are clear cut only in markets where labour and transport costs are high or where there are specific agronomic requirements favouring their use.

Although the growth factor of complexes over recent years is impressive the volume in relation to total world N use is as yet small, and it would be premature to infer that they will in due course assume a predominant role compared with the use of other forms of fertilizers.

The intensive world-wide research into soil and crop condition and plant nutrient responses and the rapid advances in the science leave much room for controversy.

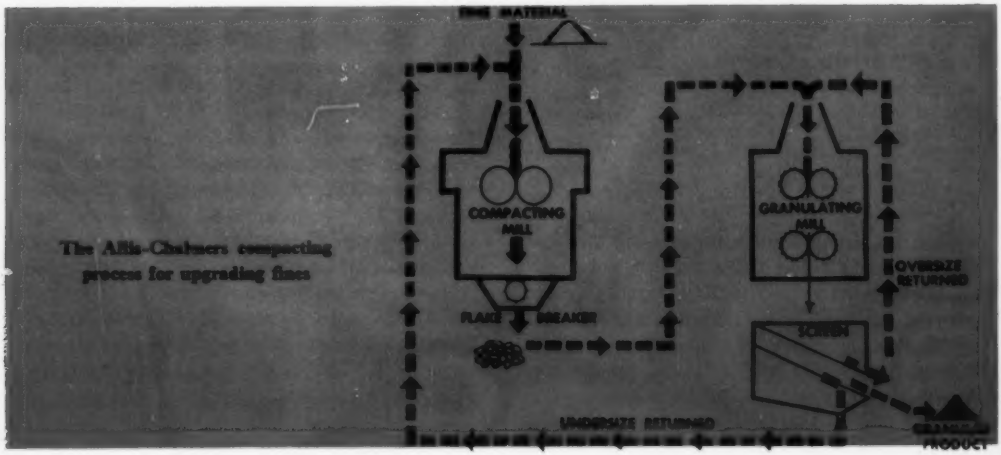
Upgrading Fertilizer Fines by Allis-Chalmers Compacting System

To upgrade and/or densify fine particle sizes of fertilizer salts, engineers of Allis-Chalmers Manufacturing Co., Milwaukee, have developed a compacting process, which is meeting with a high degree of acceptance. Interest in the process, which has been used for ammonium sulphate, di-ammonium phosphate, sodium nitrate, sodium nitrite and potash, lies in the fact that it has possibilities in blended fertilizer production.

Fines are agglomerated by passing them between smooth rolls capable of exerting pressures great enough to produce a solid ribbon for subsequent granulation to desired particle size. Flows can vary according to raw material feed size, preheating requirements, moisture and curing requirements. The compacting process flow is usually between compactor mill, granulating mill and screen.

The product produced is free-flowing and granular with, say Allis-Chalmers, close control of product size, shape and density. Packing of fines is eliminated at the fertilizer application stage and no segregation of fines occurs — a desirable feature for blended fertilizers where a homogenous product is wanted which will not degrade or segregate.

Typical commercial operations to date have ranged from about 2½ tons an hour up to about 15 tons an hour capacity, depending upon feed material, machine size and operating variables.



The Allis-Chalmers compacting process for upgrading fines

Rising Demand for Fertilizer Nitrogen

As the result of steadily mounting consumption, world supply and demand are in closer alignment than these have been for over three years. Production, which in the fertilizer year 1959/60 totalled 10.9 million tonnes N for industrial and fertilizer use, is expanding at a rate of about 7 to 8% and together with producers' stocks estimated at about half a million tonnes N, world supplies in the current fertilizer year are expected to total over 12 million tonnes N. During the recently concluded fertilizer year 1959/60 world consumption of nitrogen had risen by nearly 10% and whereas conservative forecasts for this year had envisaged an annual growth of only about 7% indications point to a continuation of last year's rate of growth. There is no single outstanding factor contributing to this trend; nitrogen fertilizer demand is rising both in the countries where agriculture is an intensive industry with high actual and unit area rates of N fertilizer application as well as in underdeveloped countries, although in the last named the pro rata growth tends to be more spectacular. The high level of planned fertilizer use in the Communist countries also contributes significantly to the overall growth picture.

As a corollary of the balanced supply position, prices of nitrogenous fertilizers have remained firm, but there has been no significant price advance. This applies generally to the large government tenders and bulk purchases by monopoly buyers where the offers submitted by the major producers, notably those in Europe, have tended to be in line, coupled with an endeavour slightly to raise the price level. In lesser markets, however, especially in some South American countries, competition remains fierce, generally for fairly small parcels, with the result that prices are lower than the general level. Nevertheless, the trend towards a more uniform world price continues and the wide price discrepancies in different markets tend to disappear. With the exception of the U.S.A., where prices have risen, domestic prices in most major producing countries are up to 6% lower than last year but they still remain substantially higher than the present level of export prices.

The immediate outlook for the fertilizer year 1960/61 remains favourable. The surplus of U.S. by-product ammonium sulphate is falling off. In Japan higher domestic demand is expected to take the edge off the anticipated increased production and the projected export target, lower than that of 1959, should not disturb world markets. Sales of nitrogenous fertilizers to China have progressed as anticipated and contributed to the satisfactory movement of material from European suppliers. Whereas it is now generally recognised that the rising demand justifies the worldwide addition to plant capacity—expected to exceed 350,000 tons N in 1960/61—the major producers are conscious of the existence of substantial potential excess capacity, coupled with the normal trade fluctuations which perpetuate the competitive state of the market. Despite the evident absence of major adverse marketing factors, the need for price restraint and caution remains in evidence.

UNITED STATES

Installed capacity of anhydrous ammonia at the start of 1960 was over 5 million short tons represented by 57 plants and equal to 4.2 million short tons N. In 1958 increased demand had raised employment to 82% of installed capacity; this year the trend has been maintained and monthly output—February excepted—has been in excess of 410,000 short tons NH_3. Output in May was 434,043 short tons NH_3, 5% more than in May, 1959, the highest monthly total to date. Simultaneously,

stocks declined to 88,576 short tons NH_3 at the end of May and the supply position remains very tight.

Ammonium nitrate also is in short supply and as approximately 70% is used industrially, notably in explosives, this product is increasingly immune from fluctuations in fertilizer markets. In May 243,550 short tons was produced, 5% less than in April, stocks at the end of May had fallen to 65,666 short tons. In contrast, ammonium sulphate is freely available despite the very low level of steel operation, now around 50% of capacity.

By-product Ammonium Sulphate

In May by-product sulphate output amounted to 61,385 short tons and since then it is reported to have further receded. Notwithstanding the low rate of by-product sulphate output—surplus quantities have been seeking export markets and Phillips Petroleum Company, one of the two major synthetic ammonium sulphate producers, is reported to have curtailed output severely and withdrawn from export markets.

As a sequel to the weak ammonium sulphate market sales of ammonia liquor from coke ovens are advancing and the April total of 3 million lb. is 60.5% greater than in the same period of 1959.

Nitric acid production of 265,080 short tons (100% HNO_3) in May is believed to have fallen off subsequently to forestall stock accumulation as consumer demand for fertilizer has fallen off seasonally.

Urea production having increased in the early months of the year, now that installed capacity has advanced to 932,000 short tons, provided ample material, liquid and solid, for the domestic market and the expansion of exports is taking up any surplus that might arise.

Ammonia Plants

The large San Jacinto ammonia plant—built by the General Services Administration during World War II at a cost of $20 million, and in recent years operated on lease basis—has been closed. It is now on offer by tender to be sold subject to the existing lease agreement.

A major outlet for Shell Chemical Company's ammonia plant at Ventura, Calif., is the complex fertilizer project in which Shell Chemical, Stauffer Chemical and Western States Chemical companies are jointly participating. Its output of solid N.K.P. fertilizers will represent an annual capacity of 50,000 tons N.

JAPAN

As the result of lower production schedules in 1959 output totalled 854,000 tonnes N, a reduction of 78,000 tonnes compared with the original plan for 1959. Domestic consumers took up 599,000 tonnes N (46,000 tonnes N more than projected), while 339,000 tonnes N were delivered to export markets. As a result, stocks at the end of the year totalled 85,000 tonnes N, compared with 168,000 tonnes N at the end of 1958.

The official plan submitted for 1960 foresees production of 983,000 tonnes N, an increase of 15% over 1959, domestic sales of 629,000 tonnes N (+5%) exports of 321,000 tonnes N (−5%) and stocks of 85,000 tonnes N, plus a reserve of 34,000 tonnes N.

The members of the council of producers are reported to be putting strong pressure on the Government to indicate reasonable measures to help settle the accrued deficit on ammonium sulphate exports—now expected to total Yen 10,000 million (£10 million) and to rationalise the ammonium sulphate industry.

EUROPE

Output of nitrogenous fertilizer continues to expand in most major producing countries. In France, where a large programme of expansion of nitrogen output is due to be promulgated as part of the overall economic plan 1962-1965, a major project has been announced by Société Unique de la Grande Paroisse, a subsidiary of Cie. St. Gobain. Designed to produce 250,000 tonnes annually of nitrogenous fertilizers based on Lacq natural gas and refinery gas from the nearby oil refinery of Antar S.A., the plant will be built at Donges, near Nantes, and is due on stream in 1962. The projected expansion of coking capacity in North France, which is to rise 50% over the next five years and which will be

undertaken by the coal-mining companies of the Pas-de-Calais and Lorraine, is due to provide a substantial increase in by-product ammonia as well as coke-oven gas for ammonia manufacture. The planned expansion of plant capacity is expected to make France one of the largest nitrogen exporters in Western Europe.

In Italy, the State-owned E.N.I. has started construction of the large petrochemical project at Gela, Sicily, which will include production facilities for nitrogenous fertilizers, notably urea. Projected capacity is 65,000 tonnes ammonia, based on oil refinery gases, from which 60,000 tonnes urea and complex fertilizers are to be produced.

In the meantime the importance of Sicily as a major source of fertilizer supply was boosted by the completion in June of the new ammonia plant of Soc. Petrolchimica at Priolo, 15 miles from Syracuse. With an annual capacity of 33,000 tonnes NH_3, it is based on fuel oil piped from a nearby refinery, and refinery gas supplied in two gas conduits.

In Norway the capacity of the Glomfjord plant of Norsk Hydro is to be raised from 65,000 tonnes N to 86,000 tonnes N at an investment cost of N. Kr 30 million (£1½ million). At present the plant produces calcium nitrate, urea and compounds and supplies a part of the ammonia requirements of the company's Erdanger plant.

Belgian Nitrogen Industry

In Belgium, contrary to the expansionist trend evident in Western Europe, consideration is being given to rationalising the nitrogen industry with a view to aligning the production facilities of ammonium sulphate to the anticipated lower demand and to expanding correspondingly the manufacture of other high analysis nitrogen products.

In Turkey the Government is reported to have planned a large-scale expansion of fertilizer production which by 1965 is to make the country independent of imports; production of 1.09 million tons fertilizer, more than three times greater than at present, is foreseen. To this end, the new nitrogen fertilizer plant at Kutahja is to be doubled to 50,000 tonnes N a year, and new works will be built at Mersin and Samsun where fuel oil or refinery gas will provide the basis of ammonia manufacture.

U.S.S.R.

Much concern is reported at the evident large fertilizer loss in the course of distribution. Poor packaging and transit losses, all the more serious as a large proportion of the output is transported in bulk, are reported to have resulted last year in 10% of the nitrogenous fertilizer output of 800,000 tonnes N having been lost.

Urea-foam containing 40% N is to be used increasingly following successful trials on cereal crops and grass. Only 2% N is water soluble the balance being released over long periods of up to three years. Production plans under the current 7-year programme are reported to have been adjusted to provide for increasing amounts of this fertilizer.

CENTRAL AND SOUTH AMERICA

Of the four projected ammonia plants to be built in Mexico under the PEMEX petrochemicals programme two will be completed in 1961. Both designed to produce 200 tons per day NH3, the plant at Minatitlan is being built by Fluor Corporation and that at Salamanca by Lummus Co. The Mexican Government is also encouraging the production of liquid and gaseous nitrogen and has offered important tax concessions and other inducements to potential investors.

In Columbia Aproquoi S.A. are installing a $12 million plant at Carthagena to produce 150 tons N per day. An ammonium nitrate plant is to be built simultaneously by International Petroleum Co.

MIDDLE AND FAR EAST

Mounting nitrogenous fertilizer demand, which is in due course to be met from projected new plants in the various countries, at present exerts a strong influence on world trade. Sustained purchases and shipments to China remain the main factor in the export pattern from Western Europe whereas in the current fertilizer year at least 280,000 tons N is expected to be shipped.

Heavy imports by Formosa—300,000 tons ammonium sulphate was purchased recently—continue to provide one of the principal markets for Japan's output.

Malaya has recently called for 500 tons monthly of ammonium sulphate for use in the Malacca rubber states. U.S. shippers have been invited to quote provided their prices are competitive with those of European and Japanese material which is used now.

In South Korea, where in July some 128,000 tonnes N in various forms was purchased by tender, a third urea plant is projected.

In Indo China a nitrogenous fertilizer plant is to be built near Tourane; its cost is to be defrayed from the greater portion of a loan of NF 70 million (£5 million) to be raised at Saigon. Capacity of the plant is to be in excess of 30,000 tonnes N, far in excess of current usage which is based an annual imports of 82,000 tonnes fertilizer.

FREIGHTS

The seasonal decline of ocean freights is being felt throughout all sections of the market. After heavy grain shipments to Japan of late rates in the Pacific declined heavily as a large volume of tramp tonnage sought employment. Chartering in fertilizer has been modest and confined in the main to China and India.

Recent charters indicate the following rates (f.i.o.):—

To :	From : Japan	U.S.A.	Europe
China	—	—	61s. 6d.
India (East Coast)	—	50s.	—
S. Korea 1	$8.50+	$11.95+	$9.50
S. Korea	$2.50	$10	$11.50*
Pakistan	—	—	$6.20
Formosa	$2.80	—	$8.00
Brazil	—	$5.50	—
Central America ...	—	$5.50	30s.

+ U.S. lines * Foreign lines

PRICES

Although prices have not advanced noticeably the world price structure is firmer. In the major markets offers from all quarters tend to be slightly higher and severe competition is in the main confined to some of the lesser markets, notably in South America. Japan's success in disposing of accumulated stocks—albeit at severe loss on the part of producers—has favourably affected the general statistical picture and the fear of widespread pressing offers of Japanese ammonium sulphate and urea is receding.

Recent sizeable sales by Japan in Far Eastern markets have actually aimed at, and succeeded in, raising the general price level. China has maintained the tenor of her nitrogenous fertilizer purchases, and is unlikely to reverse the present market trend when negotiating for the large tonnage she appears to be seeking for the current fertilizer year.

The immediate outlook points to a slight hardening of prices but all major producers, anxious to avoid the re-emergence of wide price discrepancies in different markets, can be expected to temper their desire for higher price levels with the satisfaction derived from the present reasonably stable market conditions.

EXPORT MARKETS

Ammonium sulphate

Market prices range from $28 to $35 per tonne in bulk. Prices posted by the majority of West European producers are £11 15s. ($32.90) per tonne in bulk. U.S. material derived as by-product from caprolactam manufacture is offered in export markets at prices as low as $22-33 per short tonne f.o.b.

In the tender held by South Korea early in July about 160,000 tonnes material was sold. Japan secured only about 15,000 tonnes at $42.50 per tonne f.o.b. ($45 c.i.f.). European suppliers quoting $35-37.50 f.o.b. ($45.50-47 c.i.f.) secured 78,000 tonnes. While the balance of about 63,000 is to be supplied by a wide range of U.S. suppliers who quoted $32.03 to $47.35 per tonne f.o.b. ($40.53-55 c and f). German suppliers succeeded with an offer of 9,000 tonnes of ammonium sulphate nitrate (26% N) at $43.50 per tonne f.o.b.

Ammonium nitrate

Current quotations range from $56 to 63 per tonne f.o.b. In the South Korea tender in July some 45,000 tonnes was purchased. Canada—material of 33.9% N supplied by Comico—secured 17,500 tonnes at $60.65-62.50 f.o.b. ($66.75-68.75 c and f).

Lime ammonium nitrate prices from West European suppliers range from $32 to $37.50 per tonne in bags.

Calcium Cyanamide

In the South Korean tender Taiwan secured the supply of 20,000 tons of calcium cyanamide (20% N) at $53.90 f.o.b. ($57.98 c and f).

Urea

Strong world-wide demand remains in evidence. Offers from principal suppliers range from $79-85. In the July tender, South Korea purchased over 130,000 tonnes. Japan secured 42,000 tonnes at $87-91 f.o.b. ($89.50-93.50). West European suppliers quoting $77.25-79 f.o.b. ($86.25-88.50), except for two small parcels at $85-85.50 ($97 c and f), secured 22,000 tonnes. The balance of 66,000 tonnes will be supplied by a number of U.S. suppliers at prices ranging from $83.70-95.64 f.o.b. ($95.70-105.64 per tonne c and f).

TENDER

India

The Government of India is holding a tender in September and will purchase 41,400 long tons of ammonium sulphate and 10,000 tons of urea for shipment during October-November 1960. Offers had to be submitted by 12 September and negotiations were to start about 14 September.

DOMESTIC PRICES

United States

Current posted prices are as follows :	Per short ton
Coke oven ammonium sulphate	$32 in bulk
Synthetic ammonium sulphate	$35 in bulk
Ammonium nitrate	$64 in bulk
Calcium cyanamide	$57 in bags
Lime ammonium nitrate ...	$48 in bags car loads
Sodium nitrate	$48 in bags car loads
Nitrogen solutions 40% (basis 100%)	$126 in tanks

Anhydrous ammonia is priced by the three leading producers as from 1 August at $84 which price is to adance on 1 October to $92, an increase of $4 over prices prevailing up to 31 July. In California, despite continued heavy competition in the Central Valley, the ex-works price advanced $3 on 1 August to $69. Further advances of $3 are scheduled for 1 October and 1 January.

Since 1 July urea has been priced by several leading producers on an f.o.b. basis instead of "delivered." Now at $98 per short ton f.o.b. at points in Ohio and Nebraska ($2 more for feed grades), nearby consumers can thus save up to $25 per short ton.

The price for nitrogen solutions 40% N (100% basis) supplied by Allied Chemical Company is to advance $6 after 1 January 1961 to $132. Urea solutions reduced by $2 after 1 August to $158 per short ton will advance to $164 after 30 September. Spencer Chemical Company, having dropped ammonium nitrate prices to $64 on 1 August, propose advancing these to $67 on 1 October and to $70 per short ton after 1 January 1961.

Collier Carbon and Chemical Company have boosted their posted price on ammonia from $66 to $92 per ton, plant. Collier, whose ammonia plant is in Southern California say this is a deliberate effort to set a more "realistic" price for ammonia and provide adequate profit margins for all concerned. Competitive prices in the company's marketing area will be met. Other western ammonia producers agree that reasonable profits are "practically impossible" at present selling prices. It is believed that they will raise their prices.

United Kingdom

Current quotations for material delivered to farmers' nearest railway station is as follows:—

	per ton	subsidy
Ammonium sulphate (21% N)	£19 12s.	£9 9s.
Nitrochalk (15.5% N) ...	£18 5s.	£6 19s. 6d.
" (21% N)	£23 11s. 6d.	£9 9s.
Kay Nitro (16% N- 16% K20)	£25 17s. 6d.	
Nitra Shell (23% N)	£25 16s. 6d.	£10 7s.
Sodium nitrate (16% N) ...	£22 13s.	£7 4s.

The new price levels for the fertilizer year 1960-61 are up to £1 per ton lower than those in the preceding year.

West Germany

Prices covering the period 1 July, 1960, to 30 June, 1961, are as follows:—

West German Prices

Product	per tonne N						
	July 1960 DM	August 1960 DM	Sept./Oct. 1960 DM	November 1960 DM	December 1960 DM	January 1961 DM	Feb./June 1961 DM
Ammonium sulphate (21% N)	1,035	1,060	1,080	1,090	1,100	1,120	1,140
Ammonium sulphate nitrate (26% N) ...	1,045	1,070	1,090	1,100	1,110	1,130	1,150
Calcium ammonium nitrate (20.5% N) ...	1,070	1,090	1,110	1,120	1,130	1,150	1,175
Urea (46% N)	985	1,010	1,030	1,040	1,050	1,070	1,090
Calcium nitrate (15.5% N)	1,230	1,250	1,270	1,280	1,290	1,310	1,330

PEC Processes for Production of Complete Fertilizers

Attractive Possibilities of the New Carbonitrate Process

SINCE a complete fertilizer needs nitric nitrogen and phosphate compounds, the French concern, Potasse et Engrais Chimiques (PEC) investigated the possibilities of preparing such a fertilizer by dissolving the phosphate in nitric acid instead of sulphuric acid. Three advantages were envisaged:—

- elimination of use of sulphuric acid
- elimination of production of large amounts of calcium sulphate, so producing a more concentrated fertilizer
- inherent intimate mixing of the required fertilizer constituents

After acidulation of the phosphate rock with nitric acid, acidity could be neutralised by ammonia to supply the necessary ammoniacal nitrogen. The phosphoric acid would be present in the form of dicalcium phosphate. A disadvantage, however, would be the presence of calcium nitrate formed during the reaction, since this compound is very hygroscopic. Therefore, calcium nitrate has to be eliminated or converted into a non-hygroscopic salt.

The ODDA process overcame this problem by acidulating the phosphate with 45 to 55% acid in slight excess. The liquor obtained is filtered to eliminate the insoluble elements and then cooled to $-10°C$ to cause crystallization of the calcium nitrate which is separated in a vacuum filter. In another process, that of Norsk Hydro, calcium nitrate is separated by crystallization in the form of a double salt $5Ca(NO_3)_2 . NH_4NO_3 . 22H_2O$ by addition of ammonium nitrate.

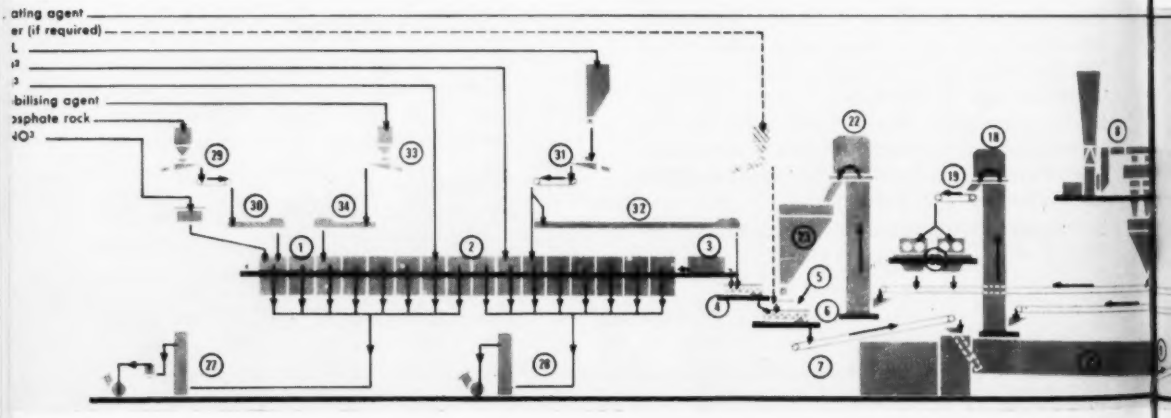
Processes using the filtration method suffer from two major disadvantages:—

- difficulty of filtering the acidulation liquor which is not only viscous at low temperature but contains colloidal particles so that complicated filtration apparatus is required
- disposal of the calcium nitrate product of which some 3 to 5 tons are obtained from each ton of soluble P_2O_5.

After research covering 20 years PEC offer a range of processes for conversion of the calcium nitrate:—

— either by SO_4 ions (sulphuric acid + ammonia or potassium sulphate or ammonium sulphate)
— or by PO_4 ions (phosphoric acid + ammonia, or ammonium sulphate)
— or by CO_3 ions (carbon dioxide + ammonia, or potassium carbonate.

This last process is new and has resulted from



an important discovery concerning the stabilisation of dicalcium phosphate.

Nitric Acidulation of Natural Phosphate

Natural phosphate* is broken down by nitric acid, and a very fluid acidulation liquid is produced. The absence of calcium sulphate facilitates the extraction of gas and the risk of combustion or explosion due to the presence of ammonium nitrate is avoided.

$$P_2O_5 : 3.5CaO + 6HNO_3 \longrightarrow P_2O_5 : 0.5Cao + 3Ca(NO_3)_2$$

Precipitation of Dicalcium Phosphate

Because of its content of free phosphoric which is not wanted in the fertilizer, is used to acid the liquor obtained is acid. This acidity fix ammonia with consequent precipitation of dicalcium phosphate

$$P_2O_5 : 0.5CaO + 3Ca(NO_3)_2 + 3NH_3 \longrightarrow P_2O_5 : 2CaO + 1.5Ca(NO_3)_2 + 3NH_4\ NO_3$$

Conversion of Remaining $Ca(NO_3)_2$

The remaining calcium nitrate is converted by precipitation of the calcium in the form of insoluble salt by the use of the alternative processes mentioned above.

Precipitation as calcium sulphate uses an original PEC process, the sulphonitric process —ammonium sulphate is obtained direct in the reaction by simultaneous addition of sulphuric acid and ammonia

$$Ca(NO3)_2 + H_2SO_4 + 2NH_3 \longrightarrow CaSO_4 + 2NH_4\ NO_3$$

Another process—the nitrosulphopotassic process—uses potassium sulphate either itself or produced by reacting sulphuric acid with potassium chloride in a separate unit

$$Ca(NO_3)_2 + K_2SO_4 \longrightarrow CaSO_4 + 2KNO_3$$

In practice the mixture obtained after precipitation of the dicalcium phosphate in stage II is mixed with potassium sulphate until the reaction is complete.

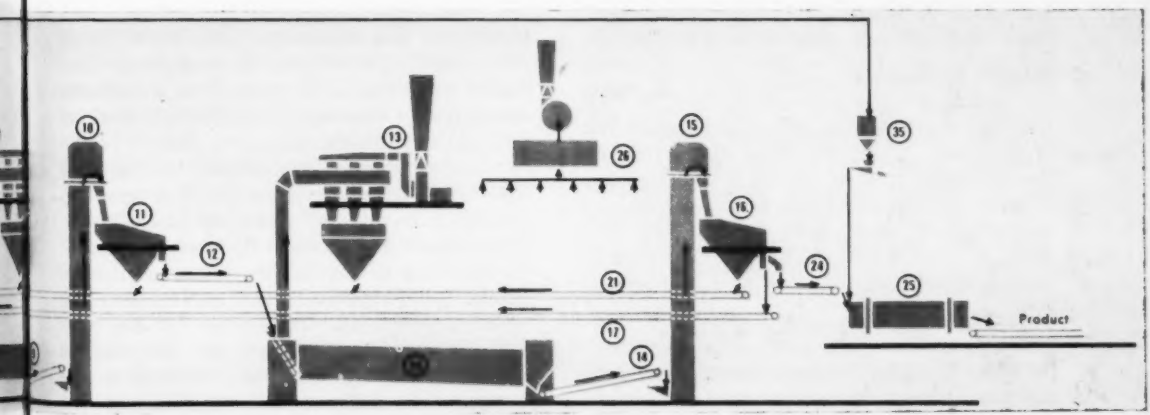
A further PEC process—the phosphonitric process—uses a similar technique to that described under the sulphonitric process with phosphoric acid being used instead of sulphuric acid

$$Ca(NO_3)_2 + H_3PO_4 + {}_2NH_3 \longrightarrow CaHPO_4 + 2NH_4\ NO_3$$

While this costs more for basic materials, this last process allows production of fertilizers of low N/P_2O_5 ratio highly concentrated in fertilizing power.

The sulphonitric process requires only 1 ton of sulphuric acid per ton of soluble P_2O_5 as opposed to 2 to 2.3 tons required in the case of superphosphate. A further improvement in cost can be made, however, by eliminating entirely the use of sulphuric acid and replacing by the cheapest form of acid

1. Acidulation reactors
2. Ammoniation reactors
3. Buffer-tank
4. Pregranulator
5. Disc feeder for fines
6. Granulator
7. Conveyor for damp product
8. Dryer and multicyclone
9. Conveyor for dry product
10. Elevator for first stage screening
11. First stage screen
12. Conveyor for oversize and product
13. Cooler and multicyclone
14. Conveyor for cooled product
15. Elevator for cooled product
16. Second stage screen
17. Conveyor for oversize to crushers
18. Elevator for oversize to crushers
19. Conveyor for oversize to crushers
20. Roll crushers
21. Conveyor for fines
22. Elevator for fines
23. Hopper for fines
24. Conveyor for product
25. Coating drum
26. Dust removal system
27. Scrubbing tower for acid gases
28. Absorption tower for ammoniacal gases
29. Weigher for phosphate rock
30. Redler conveyor for phosphate rock
31. Weigher for KCL
32. Redler conveyor for KCL
33. Stabilising agent feeder
34. Redler conveyor for stabilising agent
35. Coating agent feeder



* Formulæ are based on use of natural Moroccan phosphate containing 33.4% P_2O_5.

available—carbon dioxide. Surplus calcium is then fixed as calcium carbonate.

Since 1941 PEC have been studying the means whereby complex fertilizers can be manufactured using carbon dioxide, normally available as waste product from production of synthetic ammonia, but the necessary pH required for fixation of the CO_2 proved a difficulty. Dicalcium phosphate tends to revert to insoluble tricalcium phosphate and this reversion

$$P_2O_5 : 2CaO + CaCO_3 \longrightarrow P_2O_5 : 3CaO + CO_2$$

can take place either during the course of manufacture or subsequently during storage.

This process could be used if pure materials were used, but not using industrial materials. Stabilisation of the reaction could be effected, it was found, using magnesium (as magnesium sulphate, itself a by-product) or SO_4 ions. This stabilisation is peculiar to dicalcium phosphate.

Both dicalcium phosphate and calcium carbonate can be present together without any reaction occurring, while dicalcium phosphate can be kept soluble in ammonium nitrate when prepared in the presence of ammonia at high pH. This carbonitric process, it will be appreciated, is a very attractive one. Other than the basic materials containing the required fertilizer elements—phosphate rock, nitric acid and ammonia—only a small quantity of inexpensive magnesium sulphate and carbon dioxide, formerly wasted, are required. Even where no synthetic ammonia plant is present having carbon dioxide as waste product, this gas could be recovered in more dilute form from other sources, such as lime kilns.

Mixed Acidulation

Where a basic ratio of nitrogen to P_2O_5 less than 1 is required, mixed acidulation can be practiced. In the first stage of the reaction the phosphate rock is reacted with a quantity of nitric acid corresponding to half the amount of nitrogen in the required formula, the limit being a N/P_2O_5 ratio of 6/10. Acidulation is then completed by sulphuric acid in a second stage

$$(1)\ P_2O_5 : 3.4CaO + 4.5HNO_3 + 0.75\ H_2SO_4 \longrightarrow P_2O_5 .: 0.5CaO + 0.75CaSO_4 + 2.25Ca(NO_3)_2$$

Ammoniation is carried out together with the addition of the balance of the sulphuric acid.

PEC Complex Fertilizer Plant

Formation of the slurry takes place in a sequence of standard reactors arranged in cascade, and designed to give thorough stirring of the whole mix. Nitrous vapour formed during acidulation is removed, eliminating formation of nitrites at a later stage and preventing local supersaturation during ammoniation. No circulating pumps are required. Should it be desired to increase capacity supplementary reactors can be added either to the end of the reactor line or to the intermediate section if a U-arrangement is used. The equipment is of stainless steel (minimum life 10 years).

The raw materials are introduced independently into the reaction line, the phosphate rock over a weighing machine (29), the nitric acid through a rotameter and the stabiliser by a mechanical feeder (33); gaseous ammonia is injected into the reactors through a flowmeter and the carbon dioxide is added in the same way. If phosphoric or sulphuric acids are used, these are introduced in the normal way.

At the end of the reactor line, the slurry flows by gravity, by way of a buffer tank (3) to a pre-granulator (4). Here, if required, potassium salts as required are added, measured by a weigher (31).

The slurry mixture is then granulated in the granulator (6) where it is mixed with returned fines from the hopper (23), and possible also solid phosphatic fertilizer and/or filter. Granulation is carried out in a paddle or drum-type mixer without complicated machinery. The vanes and walls of the mixer are scraped periodically to avoid wear and undue consumption of power. Two granulators are normally installed in parallel, one working and the other in reserve.

Damp granules are carried by conveyor belt (7) to the rotary dryer (8). The temperature of gases entering this dryer is 150-300°C depending on the formula. Build-up of material in the dryer is avoided by automatic control of the gas temperature and supervision. The dried granules are transported by conveyor belt (9) and elevator (10) and screened to separate fines. The fines are returned to the hopper (23) Both oversize and marketable granules are cooled in the cooler (13) and a

further screen (16) separates both fines and oversize from the marketable product. The oversize product is ground on crush-rollers (20) and this material and the screened fines are sent back to the fines hopper.

If desired the finished product can be coated before being sent to store. This is done in a rotary drum (25) fed with coating agent from a further hopper (35). Acid gases released in the first reactors are scrubbed (27) before being discharged to atmosphere. Any ammonia in the gases discharged by the later reactors (i.e., in the carbonitric process) is recovered in an absorption tower (28). Dust is eliminated both outside and inside the building by cyclone extractors at the outlets of the dryer and the cooler (26) and by a complete plant vacuum cleaning system.

The entire installation is automatic with raw materials weighed or measured continuously by belt-weighers or rotameters. Little supervision is required and there is a minimum of manual operation. A control panel deals with feeding of raw materials and a second panel, which can be combined with the first, carries temperature recording instruments. A PEC plant can be operated by shift staff comprising only five men and one foreman.

Licensees for PEC processes in the U.K. are Humphreys and Glasgow Ltd.

Showa Denko K.K.

A Major Producer of Fertilizers and Nitrogen in Japan

EXPANSION and diversification have marked the post-war development of Showa Denko K.K., the chemical and metallurgical combine prominent among Japan's major producers of fertilizer and technical nitrogen. The company was formed on 1 January, 1939, by the amalgamation of Nihon Denki Kogyo K.K., manufacturing aluminium, electrodes, abrasives, ferro-alloys and chemicals, and Showa Hiryo K.K., a chemical fertilizer producer. Both parent firms had developed during the infancy of the Japanese chemical industry and both made important use of hydro-electric power.

Nihon Denki Kogyo K.K. was founded in 1906 to engage in the production of iodine from seaweed. The interests of the company spread to the manufacture of potassium iodide, potassium chloride, potassium chlorate and having expanded production of electric power, to ferro and ferri cyanides, caustic soda and sodium cyanide. Later operations extended to the production of electric furnace products including calcium carbide, silicon metal and ferro-alloys and finally to aluminium.

It was with Showa Hiryo K.K., however, that the nitrogen side of Showa Denko's activities originated. This company was formed in October 1928 with the erection of a plant at Kanose, Niigata prefecture, to manufacture calcium cyanamide using the 50,000 kW output of the Kanose power station. The initial capacity of this plant, which is still in operation, was 70,000 tonnes a year. In April 1931 Showa Hiro embarked on the manufacture of ammonium sulphate in a 150,000 tonne per year plant at Kawasaki, becoming the first to use a Japanese process and Japanese equipment. Initially, all hydrogen for ammonia synthesis was obtained by electrolysis but in November 1933 additional capacity based on the use of semi-water gas and permitting the manufacture of 75,000 tonnes of ammonium sulphate a year was installed. The next capacity increase at Kawasaki—of another 75,000 tonnes of ammonium sulphate a year was completed in November 1936 and was based on the use of water gas. In November 1940 a further 25,000 tonnes of ammonium sulphate capacity, based on the use of semi-water gas, was installed bringing the total capacity of the works to 325,000 tonnes a year.

With the formation of Showa Denko K.K. in 1939 emphasis in the new company was placed on increasing the output of aluminium, electrodes, ferro-alloys, abrasives and industrial chemicals and four more power stations were commissioned. During World War II aluminium production was seriously affected by air raids, while the greater part of the

ammonium sulphate works at Kawasaki was destroyed.

Post War Development

With a steeply rising demand, the emphasis in the company's post-war rehabilitation effort centred on regaining its former level of fertilizer production and by September 1948 reconstruction at the Kawasaki works had restored capacity to a level of 300,000 tonnes of ammonium sulphate a year. Subsequent repair and extension work raised the capacity to 444,000 tonnes by April 1956. Calcium cyanamide capacity was also increased to 200,000 tonnes a year, or one-third of the total Japanese capacity, following the reconstruction of the Kanose works and the conversion by 1949 of the Toyama, Shiojiri, Chichibu and Asahigawa works to fertilizer manufacture. Production of calcium cyanamide has since been rationalized with operations concentrated at Kanose and Toyama. Capacity has been reduced to 153,000 tonnes a year, but slackening demand has resulted in production being held at a level of 125,000 tonnes a year or one-quarter of Japan's total output.

Urea

In September 1955 a urea plant was completed at the Kawasaki works with a capacity of 30,000 tonnes a year employing the Toyo Koatsu partial recycle process. This capacity has since been raised to 80,000 tonnes a year. By March 1959 work was completed on the first stage of the conversion and reorganisation of the ammonia synthesis facilities at Kawasaki. A Texaco synthesis gas generator and a Casale synthesis unit were installed by the Foster Wheeler Corporation of New York, the additional capacity of 30,000 tonnes a year being based on the partial oxidation of fuel oil. The second stage, completed in December 1959 involved the replacement of the water and semi-water gas installations by the use of petroleum refinery waste gas.

Current Operations

At the Kanose and Toyama works calcium cyanamide production will continue. The Kanose works also manufacture calcium carbide, acetaldehyde, acetic acid, ethyl acetate, butyl acetate, vinyl acetate and paraldehyde. Fused phosphate is produced at the Toyama works and is used in the manufacture of a compound fertilizer together with calcium cyanamide and potassium. Fused phosphate is also used in the company's Yokohama works in the manufacture of calcium superphosphate which is compounded with ammonium sulphate and potassium. A double nitrogen based fertilizer, a mixture of urea and calcium cyanamide, is also produced by Showa Denko K.K. This material is available in two grades with nitrogen contents of 32% and 28%. Other fertilizers manufactured by Showa Denko and containing urea are the compounds 10:7:6 and 10:10:7.

In 1960 the following capacity will be available at the Kawasaki works :—

Anhydrous ammonia		
by electrolysis	68,000	tonnes p.a.
from refinery waste gas	36,300	,, ,,
from fuel oil	38,000	,, ,,
	142,300	
Urea	80,000	tonnes p.a.
Ammonium sulphate	344,300	,, ,,
Sulphuric acid (100% H_2SO_4) ...	202,400	,, ,,

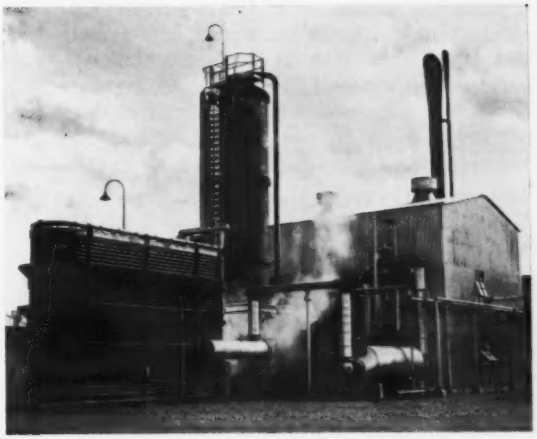
In the industrial field the expansion and diversification of Showa Denko continues. Aluminium products are manufactured at Yokohama, Omachi and Kitakata while ferro-alloys are produced at Omachi, Shirojiri, Chichibu and Hijashi Nagahara. A wide range of industrial chemicals including ammonium perchlorate, caustic soda, hydrochloric acid, melanine and sodium cyanide is manufactured at Kanose, Higashi Nagahara, Yokohama and Tateyama. Abrasives are manufactured at Shiojiri and electrodes at Omachi and Kanose. In addition Showa Denko K.K. have embarked on research on the production of reactor graphite and heavy water to meet the anticipated demands of a Japanese atomic industry.

Growing Interdependences

As with many other leading chemical concerns in Japan, nitrogen production is but one facet of Showa Denko's activities, and yet, as operations expand and diversify, it is becoming ever more closely related to other manufacturing processes carried out by the company. This trend of growing interdependence between manufacturing processes for raw materials and energy is evident not only in Japan but throughout the world and is forming a pattern which the future development of the nitrogen industry is likely to follow.

Calspray's Second Fertilizer Plant

Combines C & I Spherodizer with PEC Process



The cooler-condenser, absorption tower and nitric acid plant at Kennewick

WITH the start-up of their new $5 million fertilizer plant at Kennewick, Washington, California Spray - Chemical Corporation (Calspray) now rank as the second largest producer of nitrogen fertilizer in the United States West. The company already operates a $4 million fertilizer complex at Richmond, California.

Calspray's new plant consists of four major units—a 150 tons/day nitric acid plant (based on 100% acid), an ammonium nitrate facility rated at 200 tons/day of nitrate solutions or 150 tons/day of dry prilled product, a complex fertilizer plant designed to produce 300 tons/day of pelleted complex foods and a liquid fertilizer plant producing aqua ammonium (20%N) and anhydrous ammonia (82%N).

Full operation of the plant began in April when the plant foods unit went on stream. Construction of the plant was started in March 1959 and as with their Richmond complex, completed in 1956, design and construction were handled by Chemical and Industrial Corporation, of Cincinnati.

There are two innovations at the Kennewick plant. One is that C. and I.'s spherodizer process is combined with Calspray's modified PEC (Société Potasse et Engraise Chimiques) process. This combination gives

- a superior pelleted product
- greatly reduces recycle rate
- eliminates the need for the maze of equipment required by conventional plants.

The other noticeable feature is the small prilling tower of the ammonium nitrate plant—only one-third as high as many conventional towers. C. and I. say that the reason for the reduced height is the preconcentration of ammonium nitrate to an almost anhydrous melt. This minimises the free fall to permit prills to solidify completely and produces prills that can be handled more easily than those made from 95-96% nitrate solutions.

Nitric Acid Facility

The 150 tons/day nitric acid plant is a C. and I. type high pressure unit and is a modification of the Du Pont process burning ammonia over a platinum catalyst and absorbing the oxides under pressure. Anhydrous ammonia is piped from the nearby Phillip Pacific Chemical Company. Acid of 100% HNO_3 is produced at a 57% concentration. The plant is equipped with an electric motor-driven centrifugal compressor and expander turbine and is the most modern of its type in the U.S.A. A reheater heats the waste gas for use in the power recovery turbine to permit maximum economy, and a waste heat boiler located in the hot gas stream between the air heater and a platinum filter. This boiler produces process and heating stream in excess of plant requirements, and combined with the power recovery turbine, makes the C. and I. nitric acid plant almost self-sustaining. The platinum filter in the combustion gas stream collects the finely-divided platinum mechanic-

Besides production of 150 tons of fertilizer grade prilled ammonium nitrate, this facility can make quantities of ammonium nitrate, ammonia solutions and other fortified nitrogen solutions.

Complex Fertilizer Plant

This plant incorporates the PEC* acidulating and ammoniating sections, together with C. and I.'s spherodizer. The process is flexible and is subject to numerous variations for the purpose of producing any of the high analysis grades of fertilizer and ammonium phosphates. Acidulation of the phosphate rock and the ammoniation are carried out in a series of stainless steel vessels of special design. These are water-jacketed and provided with motor-driven agitators. Nitric acid and phosphate rock are added to the first three vessels, and the slurry flows continuously through the acidulation and ammoniating vessels, which are connected in series.

Gases and vapours from the reaction vessels are vented through a duct system and treated in a fume scrubber for removal of noxious fumes. From the final ammoniation vessel, the slurry flows to a slurry mixing tank where in the potash and slurry surge tank sufficient time is allowed for all chemical reactions. The slurry is then sprayed into the spherodizer under pressure. This process produces all the P_2O_5 available as plant food. Potash can be added if a complete fertilizer is wanted.

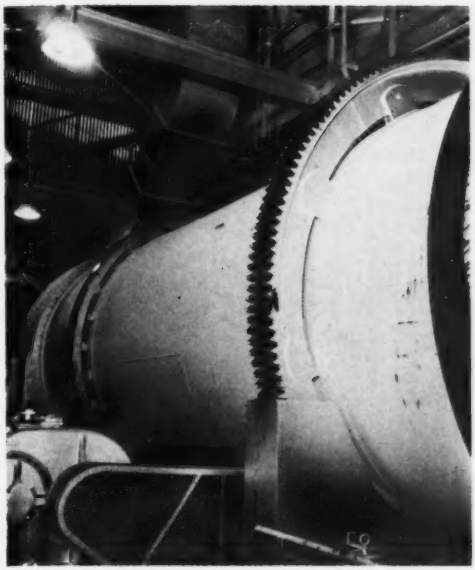
* See Page 22

The Spherodizer

In the spherodizer the slurry is pelletized and dried. As such the process differs from other granulating methods in that the pellet formation and drying are carried on simultaneously. This is accomplished by continuously spraying the feed slurry onto curtains of falling particles showered through hot drying gases in the rotating drum. Flights (or baffles) inside the spherodizer are large enough to lift the entire bed of pelletized material and shower it down through the incoming spray. A surface-drying action takes place and prills with an onion-like layer structure are formed. Pellets ranging from 1.5 to 0.03in. in diameter can be made. The desired size range is 0.185 to 0.065in. (4 and 10 mesh).

The spherodizer is similar to a large diameter, short-length rotary dryer. Size of the dryer depends on plant capacity. Thus the area required for a 159-ton-a-day plant is about 30ft. x 60ft.

Calspray's ammonium nitrate prilling tower (overall height is approximately 60ft.)

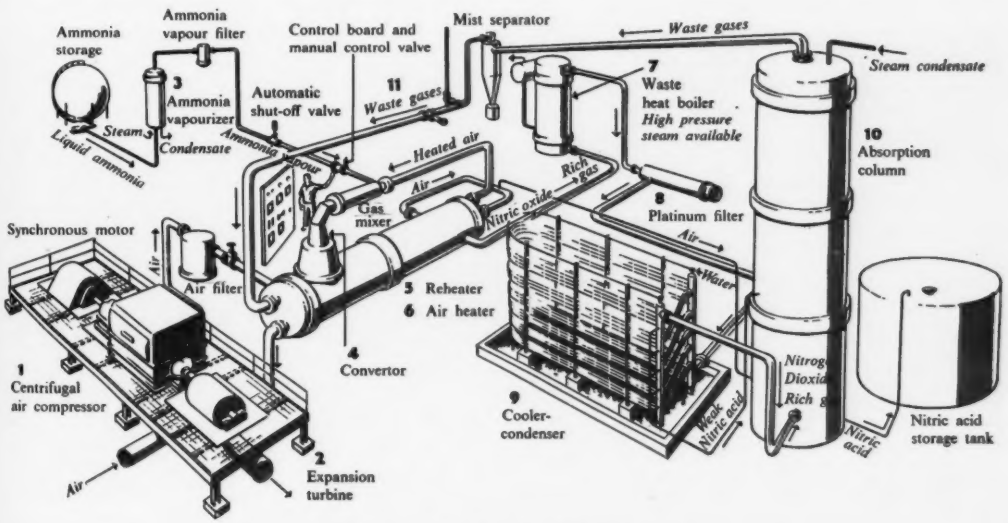


Spherodizer designed and constructed by C. & I. Co.

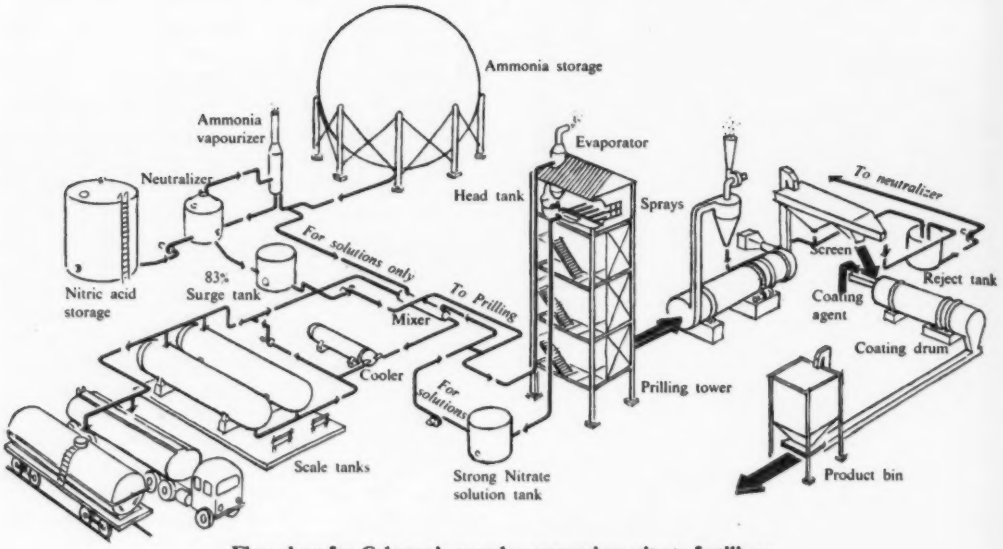
ally displaced from the catalyst bed. Cooling and oxidizing of the gases takes place in a multi-pass, horizontal cascade-type cooler. The acid condensed in this cooler is delivered to the proper plate in the absorption column. Uncondensed gases, primarily N_2 and NO_2, and oxygen enter the base of the bubble-plate absorption column and flow upward, countercurrent, to water (steam condensate) which is used as the absorbing medium. Acid in the base of the column is swept by a stream of hot air or combustion gas and delivered to storage tanks.

Prilled Ammonium Nitrate

Ammonia is vapourized by the steam from the stack of the neutralizer and is sparged into the body of the neutralizer together with nitric acid. A ratio controller automatically maintains the proper proportions of ammonia and acid while the heat of neutralization evaporates a part of the water and gives a solution of 83% ammonium nitrate. This liquor is pumped to a single stage evaporator. Final evaporation to above 99% is accomplished in a falling film evaporator located at the top of the low (60ft.) prilling tower. Prills are fed to a rotary cooler. Fines from the cooler are collected in a cyclone, and eventually are returned to the neutralizer. After cooling the prills are screened to size. Intermediate or product size prills are dusted with a coating (usually diatomaceous earth).



Nitric acid flow sheet for Calspray plant



Flow sheet for Calspray's complex ammonium nitrate fertilizers

An advantage of the spherodizer is that it does not depend on restricted water content —just as long as the moisture is below the agglomerating point. The surface-drying action gives a dry bed, and the pellets formed are product-dry. Cutting out the necessity of recycling lowers capital investment cost. Temperatures used depend on the product being made; most fertilizers are prilled in the wide range between 150°F and 210°F. Excessive melting occurs at less than 140°F.

The complex plant foods unit is scheduled to turn out three types of pellets: 14 - 14 - 14, 20 - 10 - 0 and 20 - 20 - 0 (N - P_2O_5 - K_2O ratios). The primary plant nutrients exist mainly as ammonium nitrate, dicalcium phosphate, potassium nitrate and ammonium chloride.

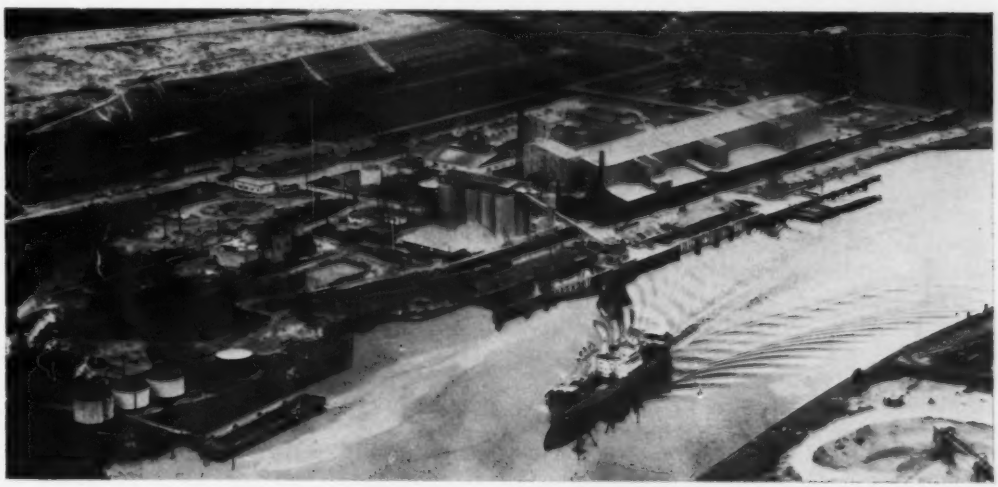
Following the successful operation of their Kennewick plant, Calspray have now announced plans to build a $22 million nitrogen fertilizer plant at Fort Madison, Iowa, the company's first east of the Rockies. Output will be marketed to farmers in the North Central states, a marketing area not now served by Calspray. This new Iowa plant will be designed to produce 300 tons a day of anhydrous ammonia, 150 tons of prilled ammonium nitrate, and 600 tons of complex pelleted plant foods. Construction will be begun this autumn; the plant should be in operation by the autumn of 1961.

New High-analysis Fertilizer Unit for Olin Mathieson's Pasedena Plant

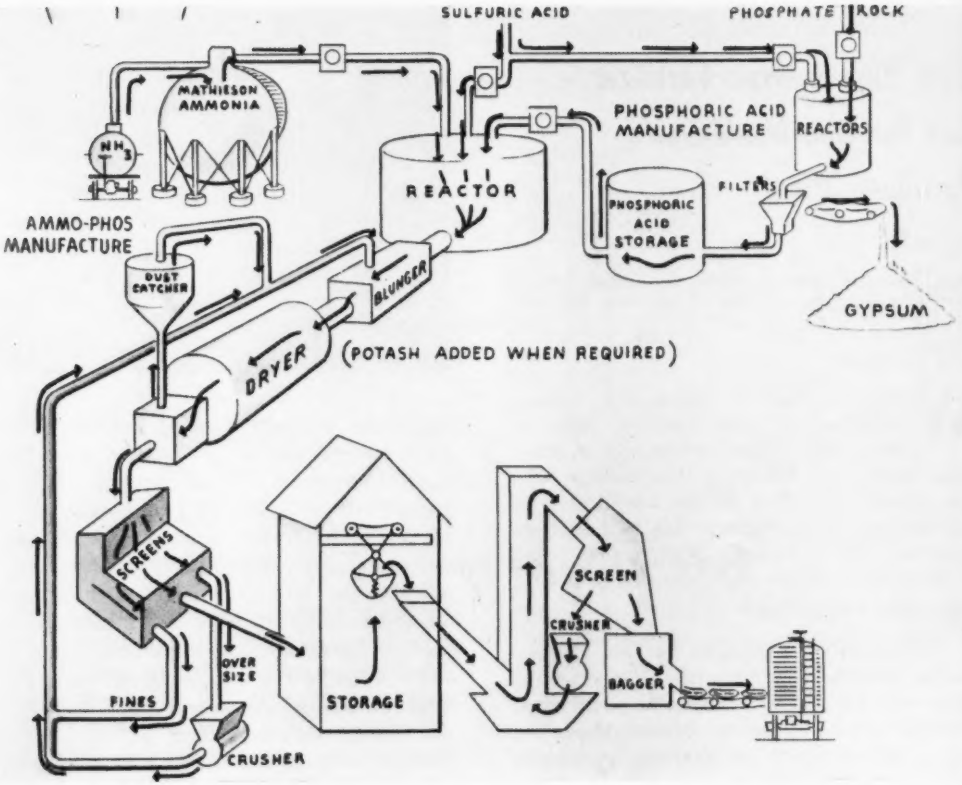
High analysis fertilizer pellets are dried in this giant tube dryer at the rate of 150 tons per hour

WITH the start-up of a $1.5 million addition to their fertilizer plant at Pasadena, Texas, at the end of May, Olin Mathieson Chemical Corporation can now claim production in the world's largest high analysis fertilizer plant. The new addition gives the plant a capacity of more than a ton of pelletized fertilizer every minute—or a 40% gain over former output.

This additional capacity for Olin Mathieson has been designed primarily to increase the company's line of high-analysis fertilizer made principally from ammonia, sulphur, phosphate and potash. High analysis fertilizer is generally considered to be any mixed fertilizer with a plant nutrient content of 30% or more. Thus a fertilizer with 12lb. of nitrogen, 24lb. of phosphorus and 12lb. of potash (12 - 24 - 12) for every 100lb. has a total of 48% plant nutrients and representing more plant nutrient per unit of product than ordinary fertilizers bring the farmer greater yields, facilitate spreading, ease aerial application and entail lower investment. In recent years these fertilizers have grown very popular. In 1949, in the U.S.A., they accounted for 12% of all fertilizer used. In 1959 41% of 25 million tons



Olin Mathison's high analysis fertilizer plant. Lower left is the sulphuric plant; in the centre is the main plant with the new addition, and upper left is the gypsum mound



of fertilizer used was of the high analysis type. This included 550,000 tons of the ammonium phosphate type.

Olin Mathieson's Pasadena plant is favourably located with regard to transport facilities. Phosphate rock arrives via the Gulf of Mexico from the Tampa area in Florida; liquid sulphur comes in tankers from Texas; ammonia comes from the company's nearby Lake Charles, La, Plant, and potash comes from the Carlsbard area in New Mexico.

The plant was built by the Government during World War II and in 1947 was purchased from the Government. It began operations in 1945.

Existing process patterns are being followed at the Pasadena plant—making wet-process phosphoric acid from Florida phosphate rock; reacting phosphoric acid with ammonia and pelletizing ammonium phosphate, with or without the addition of potash.

Of the six main processes by which fertilizer phosphorus can be manufactured—the superphosphate process, triple superphosphate process, nitric acid phosphate process, furnace process for phosphoric acid, diammonium phosphate process, and the Ammo-Phos process, Olin Mathieson use a combination of these. Thus ground phosphate rock is reacted with sulphuric acid to produce phosphoric acid and waste gypsum. Phosphoric acid is then reacted wth ammonia to produce mono - ammonium phosphate (Ammo - Phos 11 - 48 - 0). Or ammonia is reacted with a mixture of phosphoric and sulphuric acids to produce a chemical mixture of mono-ammonium phosphate and ammonium sulphate to produce other grades of Ammo-Phos such as 16 - 20 - 0, 15 - 30 - 0 and 13 - 39 - 0. Potash is also added to produce N - P - K grades such as Ammo - Phos 12 - 24 - 12, 6 - 24 - 24. The

chemical compound produced is pelletized, dried and then screened before storage in bulk or bags.

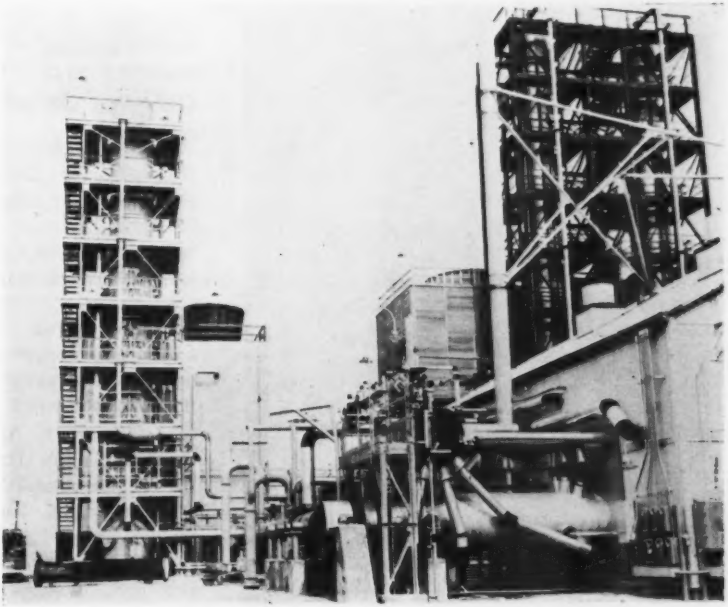
With the new addition to the Pasadena plant, Olin Mathieson are adding new grades to their Ammo-Phos line. Among them are 15 - 15 - 15, 16 - 48 - 0, 14 - 28 - 14, 7 - 28 - 28, 9 - 36 - 18, 13 - 39 - 13 and 12 - 24 - 24.

120-Ton-Day Nitric Acid Plant for Co-operative Farm Chemicals

On stream at Lawrence, Kansas, is the 120-a-ton-day nitric acid plant of Co-operative Farm Chemicals Association, designed and constructed by Chemical Construction Corporation, U.S.A.

The major consumer in a nitric acid plant is the air compressor which requires 600 to 650 horsepower hours per ton of acid produced. In this C.F.C.A. plant, the tail gas is heated to 900°F by exchange with the hot process gas before and after the waste heat boiler. Hot tail gas is then expanded through a gas turbine which supplies about 55% of the total power to drive the air compressor.

At Lawrence, atmospheric air is compressed to about 8 atmospheres at 450°F; about 80% of this air is filtered and mixed with superheated, filtered ammonia vapour. The mixture then passes to a converter and over a platinum-rhodium gauge catalyst. Hot gases leave the catalyst reaction chamber at about 1,650°F and pass through a tail gas heater, waste heat boiler, catalyst recovery filter, tail-gas foreheater and water-cooled condenser, where the gases are cooled to 140°F before flowing to the absorption tower. Nitric acid is continually converted to the dioxide, which is absorbed in make-up, water and weak acid in the tower. The 60% nitric acid formed leaves at the bottom of the tower. The tail gas, mostly nitrogen, leaves the top of the tower, is heated by exchange with burner gases in the units mentioned previously and is expanded through a gas turbine which supplies the power to drive the air compressor.



Co-operative Farm Chemicals Association's new nitric acid plant at Lawrence, Kansas

plant and equipment

NEW M.S.A. NITROGEN DIOXIDE DETECTOR FOR CONCENTRATIONS OF 0.5 p.p.m.

DEVELOPMENT of a nitrogen dioxide detector is announced by **Mine Safety Appliances Co. Ltd.,** Queenslie Industrial Estate, Glasgow, E.3, which indicates NO_2 concentrations from 0.5 to 50 parts per million. No mixing of chemicals is required, and the detector can be used in contaminated atmospheres or from remote location.

The instrument is compact and lightweight, and is contained in a small tubular case, supported by a shoulder strap. Tests are made by drawing samples of an atmosphere through a tube filled with an impregnated chemical which changes colour if the atmosphere contains nitrogen dioxide. Concentration is determined by comparing the length of the colour stain with an accompanying scale.

To sample for quantitative determination of nitrogen dioxide, the ends of the detector tube are broken off using the breaker hole provided in the instrument frame for the tapered end. The tapered end is inserted into the frame and the spring-loaded retaining head is adjusted over the other end. The inlet is placed in the atmosphere to be tested and the aspirator bulb is squeezed suddenly and forcible, then released and allowed to inflate completely. For greater sensitivity a total of three aspirations is made, each squeeze being started immediately after the preceding inflation. The scale provided is rotated to correspond with the number of squeezes and the zero line is matched with the beginning of the stain. The concentration of nitrogen dioxide in the air is then read at the point which is opposite the other end of the stain; sampling from a remote location is carried out by attaching a length of sampling line to the inlet connection on the retaining head.

Oxides of nitrogen are allowed to a maximum concentration of 5 parts per million. Normally the oxides react or oxidise to form nitrogen dioxide which combines with the mucous of the lung tissues to form nitrous and nitric acid. Monitoring of suspected atmospheres is particularly important since the odour threshold of NO_2 is about the level of the recommended M.A.C. of 5 p.p.m. Continued exposures to concentrations much above this value may produce obvious and irreparable harm. One of the greatest hazards of exposure to NO_2 comes from the fact that effects, except in cases of extremely high concentration, are not felt until several hours after exposure.

The M.S.A. nitrogen dioxide-in-air-detector complete with carrying case and 12 detector tubes is priced at about £22/10/-.

CENTRIFUGAL PUMPS WITH CERAMIC LININGS

DESIGNED to take advantage of the high acid resistance of ceramic materials while at the same time embodying modern design conceptions are the new centrifugal pumps developed by **Craig Pumps Ltd.,** Burnfield Road, Giffnock, Glasgow. Ceramic linings have been used as a lining rather than as a load-bearing material and have resulted in a construction which vertically eliminates the possibility of damage from mechanical shock and gives great rigidity with, it is stated, excellent impeller alignment. The ceramic linings are bonded to cast iron casings. Open-type impellers which can pass solids in suspension are produced in tough shock-resisting ceramic or acid-resisting metal alloys. Also available are solid titanium impellers. Range covers duties to 120ft. head; while capacities to 400 gallons per minute and temperatures to 100°C can be accommodated.

SHAW RECORDING HYGROMETER ALARM

SHAW MOISTURE METERS, Rawson Road, Westgate, Bradford, have developed a new recording hygrometer alarm which uses a unique sensing element. It records continuously the humidity of any atmosphere, hot or cold, dry or damp, under pressure or vacuum and gives immediate warning of any alteration in dew point or humidity. Range is a particular feature, being 10 million to 1, while sensitivity is claimed to be "100 times that of any other method." Also dew points down to −150°C can be measured for the first time. The instrument will work efficiently in dusty conditions without attention. This new moisture meter could find a useful application in fertilizer manufacture and storage.

CENTRIFUGAL COMPRESSOR for HNO_3 PLANTS

FOR pressure nitric acid plants, Gutehoffnungshutte Sterkrade AG, West Germany, have developed a combined multistage, centrifuge blower and expansion turbine. Constructed in stainless steel, it has five radial stages for compressing the nitrous gases to the absorption pressure, plus a single turbine expansion stage, mounted upon a common shaft, through which the exhaust gases from the absorption system are expanded. An electric motor connected to the free end of the shaft via an epicyclic gear supplies the difference between required and recovered power. Oil-free compression, simple and cheap maintenance, and reduced bearing losses through the mounting of compressor and expander upon a common shaft are the advantages of this combination.

For the compressor section, Gutehoffnungshutte Sterkrade give the following data:—

Nitrous gas throughout	**20,600 mm./hr.**
Compression rates	**2.7 approx.**
Operating temperature	**33°C**
Power required	**1,290 KW**
R.P.M.	**6,140**

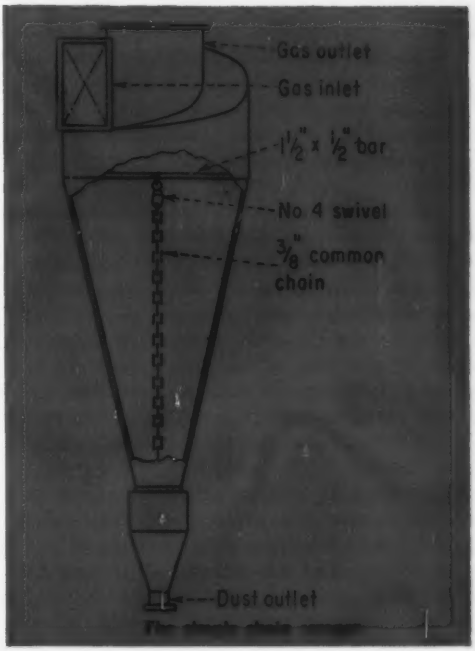
and for the expander the performance figures are:—

Amount of gases	**16,000 Nm^3/h.**
Inlet pressure	**2.8 atm.**
Outlet pressure	**1.1 atm.**
Temperature of inlet gases	**170°C**
Power recovery	**420 KW**

Preventing Hygroscopic Fertilizers from Sticking to Dust Collectors

A SIMPLE chain scraper devised by A. J. Stewart, Chemical Construction Corporation, New York, N.Y., U.S.A., prevents hygroscopic dust such as urea and triple superphosphate from sticking to the inclined walls of cyclone-type dust collectors. Directly on the centre line of the collector, a length of chain some 2ins. longer than the vertical height of the hopper sides is supported by welding a flat bar inside the collector, just above the bend line. The chain hangs from this by means of a swivel.

The vortexing action of the gas stream moves the scraping chain rapidly along the inclined side of the collector, preventing any dust from adhering. To prevent noise, a 2in. or 3in. layer of fibreglass and other sound absorbing insulation can be used.



INDIA

New Fertilizer Projects

One of Simon-Carves Ltd.'s most recent orders is for a fertilizer plant for Ennore, North Madras. The project is being partially financed by a loan of £600,000 from the Commonwealth Development Finance Company as a result of an agreement with East India Distilleries and Sugar Factories, Madras. Annual capacity of the plant, the first in India to produce diammonium phosphate, will be approximately 51,000 tons.

Nearing completion is the Nangal fertilizer project of Hindustan Chemicals and Fertilizers Ltd. It is due to be in production towards the end of this year, when adequate electric power from the Bhakra hydroelectric scheme will become available for the project.

Scheduled to start production in 1962 and 1963 respectively are the fertilizer factories at Rourkela and Neyveli. Much has been done towards the establishment of a Bombay fertilizer plant. Contracts for the major units in this project are to be awarded by the end of this year or early 1961, and the completed factory will start production by the end of 1963.

A smaller project is that destined for Assam based on natural gas from the Naharktiya oilfields, although an alternative project provides for the use of coal gas derived from high sulphurous coals to yield 33,000 tons N in the form of ammonium sulphate. Some 332,500 tons of nitrogen a year are expected to be produced, some urea (50,000 tons a year), and some as ammonium sulphate (50,000 tons a year), which will meet Assam's requirements.

Fertilizer operations at Sindri are to be merged with the three projects under the charge of Hindustan Chemicals and Fertilizer Ltd., and it is suggested that this merger will be followed by that of both Neyveli and Rourkela fertilizer projects.

UNITED STATES

Potassium Nitrate by Southwest Potash

Use of potassium nitrate as a fertilizer is likely to develop speedily in the United States. This follows from the news that Southwest Potash Corporation, a subsidiary of American Metal Climax (New York), plan to build a $7 million plant at Vicksburg, Missouri, to make potassium nitrate and chlorine, using a process they have developed in conjunction with Jacobs Engineering and the Colorado School of Mines Research Foundation. Construction is to start shortly and completion is scheduled for October 1961.

With the right price—at present $150 to $180 a ton—potassium nitrate should find an important role as a chemical fertilizer. The compound is a highly concentrated plant food with a combined potash-nitrogen plant nutrient value of 57% (13% N_2 and 44% K_2O). Its use as a fertilizer has been limited, however, because of price. Southwest's new process, which has been under development for five years, appears to have marked economic advantages. Although full details cannot be revealed as yet because of lack of patents, it is known that the process involves treatment of potassium chloride with low grade nitric acid to make potassium nitrate together with marketable quantities of chlorine and possibly, nitrogen tetroxide and 100% nitric acid. The saleable amounts of chlorine produced will help process economies; and Southwest are reported to already have a customer for this by-product. Nitrogen tetroxide, a versatile oxidiser, has potentialities as a missile and rocket fuel and the nitric acid can be used for fertilizer and explosives manufacture. One raw material — the potash — comes from the company's own reserves near Carlsbad, New Mexico.

Present industrial uses of potassium nitrate which could increase with lower prices include heat-treating salts, black powder, fireworks and ceramics. Total U.S. production is about 10,000 tons a year. The potential fertilizer market could increase consumption to more than 100,000 tons a year. Crops for which the fertilizer would be used would be tobacco, citrus and potato, as well as home gardening.

Not alone in this venture, Southwest are

likely to have Commercial Solvents, Delhi, Taylor and U.S. Potash as U.S. competitors—Commercial Solvents are known to have a process under development. In Europe a French concern is interested in potassium nitrate.

Allied to Triple Isocyanate Production

Allied Chemical Corporation are to triple production at their National Aniline Division at Moundsville W. Va. plant of toluene diisocyanate (T.D.I.) Potential at the plant by the middle of next year will be 25 million lb. Actual construction of the new facilities began in June last and the plant is expected to be completed in mid-1961. To ensure early increases in isocyanate capacity, the new construction will be done in stages.

Already in the isocyanate field in the United States are the following: *E. I. Du Pont de Nemours & Co.* with a 25 million lb. a year plant at Deepwater Point, New Jersey; and *Mobay Chemical Co.* with a plant at New Martinsville, W. Va.. This plant is now being expanded. Current capacity is 18 million lb. a year. Projected capacity by mid-year is 25 million lb. a year. *Nopco Chemical Co.* are to built a 10 million lb. a year plant in New Jersey, start up date being given as January 1962. Total T.D.I. capacity in the United States to date is estimated at 51 million lb. per year. By January 1962 this will reach 85 million lb.

In the United Kingdom the main producer of isocyanates is Imperial Chemicals Industries Limited, with some being manufactured by Hopkins and Williams. Estimated current production in the United Kingdom is 2,000 tons.

Interest in T.I.D. centres on its use in production of polyurethane products. Among these are the new well-known polyurethane foams, used increasingly in upholstery, insulation filling, etc., high-duty paints and lacquers and novel textile coating compositions. While some 5,000 tons is used in insulation filling, the remainder is used as the flexible form. This latter is considered likely to have an even wider usage than the rigid, particularly in textile applications, since clothes treated with the product can be dry-cleaned (the foams are unaffected by detergents used in dry-cleaning) and in the motor car and upholstery industries. Usage in the United Kingdom is 10,000 tons.

Because of rising demand, I.C.I. have begun work on construction and fitting out a new I.C.I. Dyestuffs Division factory near Fleetwood, Lancs., for the manufacture of chemical compounds used in making polyurethane products. As the chemicals used in production of polyurethanes—namely the isocyanates are dangerous, much of the chemical manufacturing plant will be of the open or "Dutch barn" type. At present the chemical manufacturing process is being operated on a smaller scale at I.C.I.'s Huddersfield factory. Rated capacity of this plant is believed to be about 2,000 tons; the new unit, it is suggested, will be over 10,000 tons.

Of present isocyanate usage, I.C.I. supply, it is estimated, some two-thirds of production. The remainder is imported from Farbenfabriken Bayer AG of Leverkusen, whose plant is understood to be working to capacity, and Du Pont. Other U.K. companies are looking at isocyanates with a view to producing these. Because of the raw materials required and the type of plant, a heavy capital investment is required (i.e., of the order of £1 million).

CHILE

Government take over Tarapaca Nitrate Plant

One of the few plants owned and still in operation by Cia Salitrera de Tarapaca y Antofagasta (Cosatan) — the Victoria nitrate plant — has been taken in charge by a Government commissioner. The decree authorising official intervention states that at the time of the takeover, there was an unsettled labour dispute as workers had not been paid. The company is also reported as having failed to comply with its contracts under Law No. 13620.

Difficulties at the Victoria plant followed the closing down of Cosatan's uneconomic Nebraska plant and aggravated the already serious unemployment existing in the Province of Tarapace and the port of Iquique. The Government have sent relief funds to the area.

In 1959, a Bill was presented to Congress providing for Chilean Government assistance to the Cia Salitrera de Tarapaca y Antofagasta which was producing nitrate valued at U.S.

$7.2 million annually and was expected to raise this figure to U.S. $10.2 million next year. Under the terms of the Bill the Government was authorised to purchase nitrate fields owned by the company with funds that the Government received in dollars from the sale of mechanized plants in the Province of Antofagasta of caliche extracted from Government land. The funds that the company received from these land sales was to be used solely to develop its mining activities.

With these long-term obligations to the Government, the company could not distribute dividends to its shareholders, and had to use its available profits, after serving these obligations for the following: 30% for extraordinary redemptions of long-term debts, 30% to repurchase nitrate land sold to the Government, 10% compensation to the Government and 30% to increasing its working capital.

Cia Salitrera have evidently been unable to comply with these contracts despite spending U.S. $2 million of the U.S. $11.8 million Export - Import Bank loan and an additional U.S. $1 million in local peso expenditure, hence the Government Commissioner has taken charge. The cost-price squeeze in the Chile's nitrate industry, the country's second-ranking mineral industry, has been a matter of concern for the last three years. Producers have been confronted with a combination of circumstances, such as unliquidated soft currencies from previous sales, increased operating and freight costs, and price decline owing to competition.

The new commission appointed by the Government, it is hoped will find a solution to the Chilean nitrate industry's problems.

Production of nitrate for 1959 in Chile totalled some 1,253,000 tons, compared with some 1,281,000 tons for 1958.

IRAN

Shiraz Fertilizer Works

Société Française ENSA have signed a contract with the Iranian Government for a complete technical report on, and for equipping, the first nitrogen fertilizer works in the Shiraz region.

Civil engineering and site work are being undertaken by the British company, Constructors John Brown, and the French concern, Entrepose. The plant is due on stream in 1961.

Annual production capacity of the Shiraz works will be 41,000 tonnes of lime ammonium nitrate (26% nitrogen content), 40,000 tonnes of urea (46% N), and 1,000 tonnes of anhydrous liquid ammonia.

Hydrogen, carbon dioxide and the necessary power for manufacture of the fertilizer products will be obtained from natural gas from the oilfield at Gach-Saran, about 25 miles from the factory. A gas treatment plant at Gach-Saran and a pipeline from the gas deposit to the Shiraz fertilizer works has been laid by Constructors John Brown.

The Shiraz works will use the following processes:—

- Casale process for ammonia synthesis and prior cupra-ammoniacal scrubbing of the synthesis gas.
- Société Belge de L'Azote process for nitric acid synthesis and production of ammonium nitrate.
- Fauser-Montecatini process for urea synthesis.

General engineering work, and the main units of the plant (desulphurisation, reforming, conversion, methylamine scrubbing) have been the responsibility of Foster Wheeler Française. Associated plant installations will make the Shiraz fertilizer works completely independent.

SPAIN

Ansaldo HNO_3 Plant for Spain

A plant having the capacity to produce 225 tons of 100% nitric acid a day is to be built for Compania Abonos de Sevilla of Madrid, Spain, by the Italian Ansaldo company. Societa Montecatini will co-operate with Ansaldo in construction of the plant and will supply the design. The plant is expected to cost $1.63 million.

Last year Ansaldo secured two orders for nitrogen-fertilizer plant. One of these was ordered by Yugoslavia for erection at Lukavac and was for 100 tons a day of ammonia, 335 tons of 53% nitric acid and 375 tons of 20.5% N calcium nitrate. Equipment for this $14.5 million plant is being supplied by Ansaldo with the exception of a few pieces of plant to be made locally. The other plant order for this company is that for the nitrogenous fertilizer plant being built at Neyveli.*

*NITROGEN, 6 June 1960 P.7.

Montecatini's Nitrogen Production Increased but Prices cause Concern

EXPECTATIONS that the nitrogen plants of Montecatini Societa Generale per l'Industria Mineraria and Chimica would operate at the maximum output permitted by the availability of raw material and the plant's capacity during 1959 have been realised. This statement highlights the review of Montecatini's fertilizer activities which form a prominent part in the company's annual report. Synthetic nitrogen production last year surpassed that of 1958 by 2% "despite exploitation of the situation by one of the company's major competitors." While there is every satisfaction from a quantitative point of view, the company indicates that there is less satisfaction to be derived from an examination of the effects on the price level of the "expected national overproduction."

Prices

It is often said, but not true, Montecatini report, that the increase in competition is the determining element in the decrease in nitrogen fertilizer prices. In the past the Italian nitrogen industry always made sure that it aligned its prices with those of other nitrogen-producing countries. It is also recognised, Montecatini say, that "the sales prices in effect during the most marked period of market disorganisation bear very little relationship to prices which can cover the normal costs of production accurately evaluated from all angles." This is also demonstrated by the competitive prices in other countries at least as advanced as Italy with respect to manufacturing technique and size of plant (West Germany, Great Britain, France, Belgium and the Netherlands).

Montecatini suggest that examination of this situation could eliminate several distorted interpretations, and the company is confident that such an examination will take place.

Sicilian Investments

Sicily absorbed the largest part of Montecatini's investment capital. At Priolo, the ammonia plant of their associate company, Augusta Petrolchimica, has begun operations and is now part of a vast scheme of units operating in the Augusta area.

Foreign Operations

Despite the competition in the nitrogen industry, the activity of the associated Dutch company, Compagnie Neerlandaise de l'Azote, was satisfactory. The plant at Sluiskil, Holland, has reached a capacity of 100,000 tonnes a year of nitrogen. Progress made by Ammoniaque Synthetique et Derives, with plants at Willebroeck and Tilleur (Belgium), has been less satisfactory, due especially to the particular conditions which govern the production of Belgian nitrogen.

Sale of Technology

The research efforts of Montecatini now constitute an important asset, and more than 1,200 patents were obtained in 40 countries. In the nitrogen field alone there are now 260 nitrogen plants using the Fauser-Montecatini processes.

Finances

In the year 1959, Montecatini had a net profit of L.12,412 million* as against L.10,847 million for the preceding year, after providing for all charges including L.14,500 million for depreciation of fixed assets compared with L.13,000 million in 1958. Receipts from sales rose from L.146,621 million to L.159,477 million—an increase of 8.7%. This increase was due principally to increased sales volume, while prices (particularly for agricultural products) continued their downward trend on both domestic and foreign markets. Export sales rose to L.29,082 million, or an aggregate increase of 10% over the previous year.

* £8.1 million = $22.7 million.

Staatsmijnen's Output of Nitrogen 6% Higher in 1959

PRODUCTION of nitrogen fertilizers by Staatsmijnen in Limburg amounted to 942,000 tonnes in 1959. This represents with 217,000 tonnes of pure nitrogen, which is 6% more than in 1958 and forms about 52% of the total output of the three Dutch nitrogen industries. One-half of the company's production was sold on the home-market while the other half was exported.

Increasing Competition

The increase in nitrogen production by Staatsmijnen was represented by the larger output of more valuable fertilizers, but just as the capacity of other West European nitrogen-producing industries has risen considerably in the last few years, consumption in West Europe has not increased to the same extent and hence a larger proportion of the output has had to be

exported. The Centraal Stikstof Verkoopkantoor N.V., which takes care of the sale of fertilizers, has succeeded in selling all the Dutch nitrogen production. Increasing competition from American and Japanese nitrogen producers, however, has been experienced.

Price reductions have been made for practically all the company's products; the selling value of the products, nevertheless, remained practically equal to the figure for the previous year—fl.652 million against fl.657 million. Of this total fertilizers and other chemical products contributed fl.230 million in 1959 as against fl.213 million in the previous year.

Nitrogen Production Rise

The rise in production of nitrogen was almost entirely due to an increase of the yields and throughput of the existing units. Towards the end of 1959 the nitrogen fixation works started a unit for cracking methane recovered from coke-oven gas. This allows better utilization of the various gases and also enables the various parts of the ammonia producing plant to be better attuned to each other with the result that a higher nitrogen output is obtained.

Expansion in Urea

Increasing quantities of compound fertilizers and of high nitrogen content fertilizers are being manufactured. The latter have proved very suitable for export. Production capacity of urea is being considerably extended at Staatsmijnen and part of the extension is already in operation. In 1959, urea production was thus stepped up from approximately 53,000 tonnes in 1958 to approximately 68,000 tonnes last year.

Improvement in the quality of the company's nitrogen fertilizers is being sought continually. The whole production of nitrolime (calcium nitrate) is now being delivered in the form of prills. In the near future a start is to be made in manufacturing nitrolime containing 23% nitrogen since this high nitrogen content has the advantage of making the cost of transport per tonne of nitrogen considerably lower. The composition of nitrophosphate has been altered so that there is greatly improved solubility of the phosphate component in the soil.

The very long spell of dry weather in 1959 caused the sale of nitrogen fertilizers on the Dutch market to be slightly lower than in the previous fertilizer year. During the season September 1958 to September 1959, consumption of pure nitrogen in the Netherlands amounted to some 199,000 tonnes; exports during the same period exceeded the 200,000-tonne level for the first time.

Sale of Know-how

Showing an upward trend during the last few years has been the sale of chemical know-how. Besides plants for the production of nitric acid, ammonia and several nitrogen fertilizers, a number of urea plants are under construction which will use the Staatsmijnen process.

Increased Nitrogen Fertilizer Sales for Norsk Hydro-Elektrisk

Still accounting for 78% of the total sales of Norsk Hydro-Elektrisk Kvaelshopaktieselskab (Societe Norvegienne de l'Azote) Oslo, Norway, are the nitrogenous products, calcium nitrate, ammonium nitrate and urea.

Since 1939 production of nitrogen in various forms has increased from 88,000 to 242,100 tons in 1959, a new record total representing an increase of 11,500 tons over the previous year's total. Production of calcium nitrate was slightly higher, but output of ammonium nitrate was relatively low. Total production of these products reached 1,100,000 tons and 41,000 tons respectively. Output of urea rose again from about 42,000 tons to 58,000 tons.

Some 136,000 tons of A-type complex fertilizers were produced at the fertilizer complex at Glomfjord, and 22,000 tons of B-type as well as 45,000 tons of C-type complex fertilizers at Eidanger Nitrate Works.

Output of ammonia bicarbonate was also maintained at a satisfactory level.

Sales of fertilizers in Norway have remained static, but deliveries to other Scandinavian countries increased so that 81% of all nitrogenous products was sold in Scandinavia. A new plant for the production of nitrogen using the gas by-products of the absorption plant has been in production since the end of 1959.

W. R. Grace's Expanding Activities

Mention was made of the Woodstock, near Memphis, Tennessee, facilities of W. R. Grace and Co. New York, in NITROGEN No. 5 (March 1960, p.18). The original plant facilities were constructed by Foster Wheeler Corporation of New York. The contract of the new ammonia production facilities at Woodstock has been awarded to Chemical Construction Corporation (Chemico) of New York. Construction will begin early in 1961 of the medium pressure ammonia synthesis unit. The process comprises: steam reforming at 185 p.s.i.g.; CO conversion; Co_2 removal by hot potassium carbonate followed by MEA scrubber; synthesis compression, and ammonia synthesis at 5,250 p.s.i.g. by Chemico's NEC process.

STATISTICAL APPENDIX

Japan—Exports

(tonnes product)

AMMONIUM SULPHATE

Country	1957	1958	1959
(Asia)			
Cambodia	—	135	155
Ceylon	—	813	556
China	35,200	203,242	—
Hong Kong	8,330	8,505	1,600
Korean Rep	345,243	78,788	175,535
Korean North	1,000	—	—
India	—	55,439	168,934
India Port.	—	—	257
Malaya	1,675	1,035	8,042
Pakistan East	21,500	—	—
Pakistan West	182	—	—
Singapore	1,818	1,425	1,950
Thailand	8,600	11,759	13,116
Viet Nam South	21,761	18,335	68,951
Viet Nam North	—	5,000	4,000
Sub Total	**345,309**	**384,476**	**442,736**
(Pacific Islands)			
Borneo British N.	185	50	98
Formosa	352,123	338,150	364,143
Indonesia	—	50,920	156,061
Philippines	4,811	20,167	51,180
Ryukyu Is.	15,291	13,875	16,350
Sarawak	220	—	50
Fiji	—	150	3,923
Sub Total	**372,630**	**423,312**	**591,805**
(Africa Continent)			
Egypt	—	10,000	50
Mozambique	—	40	—
Sub Total	**—**	**10,040**	**50**
(South America)			
Chile	—	—	30
TOTALS	**717,939**	**817,828**	**1,034,611**

AMMONIUM NITRATE

Country	1957	1958	1959
(Asia)			
Ceylon	—	10	—
Korean Rep.	2,554	6,025	7,019
India	—	—	1,400
Malaya	—	10	350
Pakistan East	4	—	—
Philippines	—	70	254
Singapore	—	—	5
Thailand	—	31	—
Sub Total	**2,558**	**6,146**	**9,028**
(Pacific Islands)			
Formosa	2,000	—	—
Ryukyu Is.	—	—	850
Sub Total	**2,000**	**—**	**850**
(Australasia)			
Australia	—	25	—
TOTALS	**4,558**	**6,171**	**9,879**

UREA

Country	1957	1958	1959
(Asia)			
Burma	—	1	1
Cambodia	—	—	207
China	52,133	43,715	—
Hong Kong	167	97	61
India	10	27,026	95,904
Korea Rep.	24,908	52,561	131,070
Malaya	10	20	745
Pakistan East	11,000	4	5,700
Singapore	10	51	526
Thailand	356	146	188
Viet Nam South	430	2,884	10,809
Sub Total	**89,024**	**126,505**	**245,210**
(Pacific Islands)			
Bismark Arch.	—	—	35
Fiji	—	—	1
Formosa	5,696	10,089	1,715
Guam	—	—	106
Hawaii	295	667	5,585
Indonesia	—	100	500
Marianas, Marsh and Carol Islands	—	—	2
N.E. New Guinea	—	—	77
Philippines	3,743	12,374	7,583
Ryukyu Is.	100	323	393
Sub Total	**9,834**	**23,553**	**15,997**
(Australasia)			
Australia	1,870	4,936	6,130
New Zealand	30	5	37
Sub Total	**1,900**	**4,941**	**6,167**
(North America)			
Canada	36	2	329
United States	10	—	1,913
Sub Total	**46**	**2**	**2,242**
(Central America)			
Dominican Rep.	—	—	25
Costa Rica	—	—	570
Cuba	—	140	1,292
Guatemala	—	—	60
Jamaica	—	—	102
Mexico	—	9,143	22,424
Nicaragua	—	—	207
Salvador	—	—	200
Sub Total	**—**	**9,283**	**24,880**
(South America)			
Argentina	—	—	420
Brazil	9,503	43	—
Colombia	—	—	2,850
Ecuador	—	—	10
Peru	—	1,040	5,165
Venezuela	—	—	141
Sub Total	**9,503**	**1,083**	**8,586**
(Africa)			
Egypt	—	—	15
Kenya	—	—	402
Mauritius	—	—	5
Sudan Rep.	—	—	250
Union of South Africa	—	—	1,378
Sub Total	**—**	**—**	**2,050**
(Europe)			
Denmark	—	—	1
Spain	200	400	—
Sub Total	**200**	**400**	**1**
(Middle East)			
Iran	1,000	—	1,500
TOTALS	**111,508**	**166,894**	**306,640**

Japan—Exports (continued)

AMMONIUM CHLORIDE

Country	1957	1958	1959
(Asia)			
China	16,161	23,462	—
Hong Kong	—	280	5
Korean Rep.	—	—	6
India	623	—	—
Indonesia	2	—	—
Thailand	—	—	40
Viet Nam	—	—	54
Sub Total	**16,786**	**23,742**	**105**
(Pacific Islands)			
Formosa	1	1,157	—
Philippines	2	37	29
Sub Total	**3**	**1,194**	**29**
(South America)			
Argentina	20	—	—
TOTALS	**16,809**	**24,936**	**134**

CALCIUM CYANAMIDE

Country	1957	1958	1959
(Asia)			
China	—	250	—
Korean Rep.	—	3,919	46,100
Singapore	—	—	10
Sub Total	**—**	**4,169**	**46,110**
(Pacific Islands)			
Marianas	—	—	1
Ryukyu Is.	67	82	75
Sub Total	**67**	**82**	**76**
(South America)			
Brazil	50	100	162
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Burma	200	—	—
Hong Kong	1	—	—
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(South America)			
Cuba	—	100	—
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Italy—Exports

AMMONIUM SULPHATE

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Iran	—	3,596	—
Israel	—	2,961	—
Sudan	98	495	—
Turkey	1,553	—	—
United Kingdom ...	—	553	—
U.S.A.	17,960	3,175	—
Yugoslavia	76,509	81,527	41,813
OTHERS	11,290	6,247	18,226
TOTAL	**174,912**	**375,239**	**233,968**

$7.2 million annually and was expected to raise this figure to U.S. $10.2 million next year. Under the terms of the Bill the Government was authorised to purchase nitrate fields owned by the company with funds that the Government received in dollars from the sale of mechanized plants in the Province of Antofagasta of caliche extracted from Government land. The funds that the company received from these land sales was to be used solely to develop its mining activities.

With these long-term obligations to the Government, the company could not distribute dividends to its shareholders, and had to use its available profits, after serving these obligations for the following: 30% for extraordinary redemptions of long-term debts, 30% to repurchase nitrate land sold to the Government, 10% compensation to the Government and 30% to increasing its working capital.

Cia Salitrera have evidently been unable to comply with these contracts despite spending U.S. $2 million of the U.S. $11.8 million Export - Import Bank loan and an additional U.S. $1 million in local peso expenditure, hence the Government Commissioner has taken charge. The cost-price squeeze in the Chile's nitrate industry, the country's second-ranking mineral industry, has been a matter of concern for the last three years. Producers have been confronted with a combination of circumstances, such as unliquidated soft currencies from previous sales, increased operating and freight costs, and price decline owing to competition.

The new commission appointed by the Government, it is hoped will find a solution to the Chilean nitrate industry's problems.

Production of nitrate for 1959 in Chile totalled some 1,253,000 tons, compared with some 1,281,000 tons for 1958.

IRAN

Shiraz Fertilizer Works

Société Française ENSA have signed a contract with the Iranian Government for a complete technical report on, and for equipping, the first nitrogen fertilizer works in the Shiraz region.

Civil engineering and site work are being undertaken by the British company, Constructors John Brown, and the French concern, Entrepose. The plant is due on stream in 1961.

Annual production capacity of the Shiraz works will be 41,000 tonnes of lime ammonium nitrate (26% nitrogen content), 40,000 tonnes of urea (46% N), and 1,000 tonnes of anhydrous liquid ammonia.

Hydrogen, carbon dioxide and the necessary power for manufacture of the fertilizer products will be obtained from natural gas from the oilfield at Gach-Saran, about 25 miles from the factory. A gas treatment plant at Gach-Saran and a pipeline from the gas deposit to the Shiraz fertilizer works has been laid by Constructors John Brown.

The Shiraz works will use the following processes:—

- Casale process for ammonia synthesis and prior cupra-ammoniacal scrubbing of the synthesis gas.
- Société Belge de L'Azote process for nitric acid synthesis and production of ammonium nitrate.
- Fauser-Montecatini process for urea synthesis.

General engineering work, and the main units of the plant (desulphurisation, reforming, conversion, methylamine scrubbing) have been the responsibility of Foster Wheeler Française. Associated plant installations will make the Shiraz fertilizer works completely independent.

SPAIN

Ansaldo HNO_3 Plant for Spain

A plant having the capacity to produce 225 tons of 100% nitric acid a day is to be built for Compania Abonos de Sevilla of Madrid, Spain, by the Italian Ansaldo company. Societa Montecatini will co-operate with Ansaldo in construction of the plant and will supply the design. The plant is expected to cost $1.63 million.

Last year Ansaldo secured two orders for nitrogen-fertilizer plant. One of these was ordered by Yugoslavia for erection at Lukavac and was for 100 tons a day of ammonia, 335 tons of 53% nitric acid and 375 tons of 20.5% N calcium nitrate. Equipment for this $14.5 million plant is being supplied by Ansaldo with the exception of a few pieces of plant to be made locally. The other plant order for this company is that for the nitrogenous fertilizer plant being built at Neyveli.*

*NITROGEN, 6 June 1960 P.7.

Montecatini's Nitrogen Production Increased but Prices cause Concern

EXPECTATIONS that the nitrogen plants of Montecatini Societa Generale per l'Industria Mineraria and Chimica would operate at the maximum output permitted by the availability of raw material and the plant's capacity during 1959 have been realised. This statement highlights the review of Montecatini's fertilizer activities which form a prominent part in the company's annual report. Synthetic nitrogen production last year surpassed that of 1958 by 2% "despite exploitation of the situation by one of the company's major competitors." While there is every satisfaction from a quantitative point of view, the company indicates that there is less satisfaction to be derived from an examination of the effects on the price level of the "expected national overproduction."

Prices

It is often said, but not true, Montecatini report, that the increase in competition is the determining element in the decrease in nitrogen fertilizer prices. In the past the Italian nitrogen industry always made sure that it aligned its prices with those of other nitrogen-producing countries. It is also recognised, Montecatini say, that "the sales prices in effect during the most marked period of market disorganisation bear very little relationship to prices which can cover the normal costs of production accurately evaluated from all angles." This is also demonstrated by the competitive prices in other countries at least as advanced as Italy with respect to manufacturing technique and size of plant (West Germany, Great Britain, France, Belgium and the Netherlands).

Montecatini suggest that examination of this situation could eliminate several distorted interpretations, and the company is confident that such an examination will take place.

Sicilian Investments

Sicily absorbed the largest part of Montecatini's investment capital. At Priolo, the ammonia plant of their associate company, Augusta Petrolchimica, has begun operations and is now part of a vast scheme of units operating in the Augusta area.

Foreign Operations

Despite the competition in the nitrogen industry, the activity of the associated Dutch company, Compagnie Neerlandaise de l'Azote, was satisfactory. The plant at Sluiskil, Holland, has reached a capacity of 100,000 tonnes a year of nitrogen. Progress made by Ammoniaque Synthetique et Derives, with plants at Willebroeck and Tilleur (Belgium), has been less satisfactory, due especially to the particular conditions which govern the production of Belgian nitrogen.

Sale of Technology

The research efforts of Montecatini now constitute an important asset, and more than 1,200 patents were obtained in 40 countries. In the nitrogen field alone there are now 260 nitrogen plants using the Fauser-Montecatini processes.

Finances

In the year 1959, Montecatini had a net profit of L.12,412 million* as against L.10,847 million for the preceding year, after providing for all charges including L.14,500 million for depreciation of fixed assets compared with L.13,000 million in 1958. Receipts from sales rose from L.146,621 million to L.159,477 million—an increase of 8.7%. This increase was due principally to increased sales volume, while prices (particularly for agricultural products) continued their downward trend on both domestic and foreign markets. Export sales rose to L.29,082 million, or an aggregate increase of 10% over the previous year.

* £8.1 million = $22.7 million.

Staatsmijnen's Output of Nitrogen 6% Higher in 1959

PRODUCTION of nitrogen fertilizers by Staatsmijnen in Limburg amounted to 942,000 tonnes in 1959. This represents with 217,000 tonnes of pure nitrogen, which is 6% more than in 1958 and forms about 52% of the total output of the three Dutch nitrogen industries. One-half of the company's production was sold on the home-market while the other half was exported.

Increasing Competition

The increase in nitrogen production by Staatsmijnen was represented by the larger output of more valuable fertilizers, but just as the capacity of other West European nitrogen-producing industries has risen considerably in the last few years, consumption in West Europe has not increased to the same extent and hence a larger proportion of the output has had to be

exported. The Centraal Stikstof Verkoopkantoor N.V., which takes care of the sale of fertilizers, has succeeded in selling all the Dutch nitrogen production. Increasing competition from American and Japanese nitrogen producers, however, has been experienced.

Price reductions have been made for practically all the company's products; the selling value of the products, nevertheless, remained practically equal to the figure for the previous year—fl.652 million against fl.657 million. Of this total fertilizers and other chemical products contributed fl.230 million in 1959 as against fl.213 million in the previous year.

Nitrogen Production Rise

The rise in production of nitrogen was almost entirely due to an increase of the yields and throughput of the existing units. Towards the end of 1959 the nitrogen fixation works started a unit for cracking methane recovered from coke-oven gas. This allows better utilization of the various gases and also enables the various parts of the ammonia producing plant to be better attuned to each other with the result that a higher nitrogen output is obtained.

Expansion in Urea

Increasing quantities of compound fertilizers and of high nitrogen content fertilizers are being manufactured. The latter have proved very suitable for export. Production capacity of urea is being considerably extended at Staatsmijnen and part of the extension is already in operation. In 1959, urea production was thus stepped up from approximately 53,000 tonnes in 1958 to approximately 68,000 tonnes last year.

Improvement in the quality of the company's nitrogen fertilizers is being sought continually. The whole production of nitrolime (calcium nitrate) is now being delivered in the form of prills. In the near future a start is to be made in manufacturing nitrolime containing 23% nitrogen since this high nitrogen content has the advantage of making the cost of transport per tonne of nitrogen considerably lower. The composition of nitrophosphate has been altered so that there is greatly improved solubility of the phosphate component in the soil.

The very long spell of dry weather in 1959 caused the sale of nitrogen fertilizers on the Dutch market to be slightly lower than in the previous fertilizer year. During the season September 1958 to September 1959, consumption of pure nitrogen in the Netherlands amounted to some 199,000 tonnes; exports during the same period exceeded the 200,000-tonne level for the first time.

Sale of Know-how

Showing an upward trend during the last few years has been the sale of chemical know-how. Besides plants for the production of nitric acid, ammonia and several nitrogen fertilizers, a number of urea plants are under construction which will use the Staatsmijnen process.

Increased Nitrogen Fertilizer Sales for Norsk Hydro-Elektrisk

Still accounting for 78% of the total sales of Norsk Hydro-Elektrisk Kvaelshopaktieselskab (Societe Norvegienne de l'Azote) Oslo, Norway, are the nitrogenous products, calcium nitrate, ammonium nitrate and urea.

Since 1939 production of nitrogen in various forms has increased from 88,000 to 242,100 tons in 1959, a new record total representing an increase of 11,500 tons over the previous year's total. Production of calcium nitrate was slightly higher, but output of ammonium nitrate was relatively low. Total production of these products reached 1,100,000 tons and 41,000 tons respectively. Output of urea rose again from about 42,000 tons to 58,000 tons.

Some 136,000 tons of A-type complex fertilizers were produced at the fertilizer complex at Glomfjord, and 22,000 tons of B-type as well as 45,000 tons of C-type complex fertilizers at Eidanger Nitrate Works.

Output of ammonia bicarbonate was also maintained at a satisfactory level.

Sales of fertilizers in Norway have remained static, but deliveries to other Scandinavian countries increased so that 81% of all nitrogenous products was sold in Scandinavia. A new plant for the production of nitrogen using the gas by-products of the absorption plant has been in production since the end of 1959.

W. R. Grace's Expanding Activities

Mention was made of the Woodstock, near Memphis, Tennessee, facilities of W. R. Grace and Co. New York, in NITROGEN No. 5 (March 1960, p.18). The original plant facilities were constructed by Foster Wheeler Corporation of New York. The contract of the new ammonia production facilities at Woodstock has been awarded to Chemical Construction Corporation (Chemico) of New York. Construction will begin early in 1961 of the medium pressure ammonia synthesis unit. The process comprises: steam reforming at 185 p.s.i.g.; CO conversion; Co_2 removal by hot potassium carbonate followed by MEA scrubber; synthesis compression, and ammonia synthesis at 5,250 p.s.i.g. by Chemico's NEC process.

STATISTICAL APPENDIX

Japan — Exports

(tonnes product)

AMMONIUM SULPHATE

Country	1957	1958	1959
(Asia)			
Cambodia	—	135	155
Ceylon	—	813	556
China	35,200	203,242	—
Hong Kong	8,330	8,505	1,600
Korean Rep	345,243	78,788	175,535
Korean North ...	1,000	—	—
India	—	55,439	168,934
India Port.	—	—	257
Malaya	1,675	1,035	8,042
Pakistan East	21,500	—	—
Pakistan West	182	—	—
Singapore	1,818	1,425	1,950
Thailand	8,600	11,759	13,116
Viet Nam South ...	21,761	18,335	68,951
Viet Nam North ...	—	5,000	4,000
Sub Total	**345,309**	**384,476**	**442,736**
(Pacific Islands)			
Borneo British N. ...	185	50	98
Formosa	352,123	338,150	364,143
Indonesia	—	50,920	156,061
Philippines	4,811	20,167	51,180
Ryukyu Is.	15,291	13,875	16,350
Sarawak	220	—	50
Fiji	—	150	3,923
Sub Total	**372,630**	**423,312**	**591,805**
(Africa Continent)			
Egypt	—	10,000	50
Mozambique	—	40	—
Sub Total	**—**	**10,040**	**50**
(South America)			
Chile	—	—	30
TOTALS	**717,939**	**817,828**	**1,034,611**

AMMONIUM NITRATE

Country	1957	1958	1959
(Asia)			
Ceylon	—	10	—
Korean Rep. ...	2,554	6,025	7,019
India	—	—	1,400
Malaya	—	10	350
Pakistan East	4	—	—
Philippines	—	70	254
Singapore	—	—	5
Thailand	—	31	—
Sub Total	**2,558**	**6,146**	**9,028**
(Pacific Islands)			
Formosa	2,000	—	—
Ryukyu Is.	—	—	850
Sub Total	**2,000**	**—**	**850**
(Australasia)			
Australia	—	25	—
TOTALS	**4,558**	**6,171**	**9,879**

UREA

Country	1957	1958	1959
(Asia)			
Burma	—	1	1
Cambodia	—	—	207
China	52,133	43,715	—
Hong Kong	167	97	61
India	10	27,026	95,904
Korea Rep.	24,908	52,561	131,070
Malaya	10	20	745
Pakistan East	11,000	4	5,700
Singapore	10	51	526
Thailand	356	146	188
Viet Nam South ...	430	2,884	10,809
Sub Total	**89,024**	**126,505**	**245,210**
(Pacific Islands)			
Bismark Arch. ...	—	—	35
Fiji	—	—	1
Formosa	5,696	10,089	1,715
Guam	—	—	106
Hawaii	295	667	5,585
Indonesia	—	100	500
Marianas, Marsh and Carol Islands ...	—	—	2
N.E. New Guinea ...	—	—	77
Philippines	3,743	12,374	7,583
Ryukyu Is.	100	323	393
Sub Total	**9,834**	**23,553**	**15,997**
(Australasia)			
Australia	1,870	4,936	6,130
New Zealand	30	5	37
Sub Total	**1,900**	**4,941**	**6,167**
(North America)			
Canada	36	2	329
United States	10	—	1,913
Sub Total	**46**	**2**	**2,242**
(Central America)			
Dominican Rep. ...	—	—	25
Costa Rica	—	—	570
Cuba	—	140	1,292
Guatemala	—	—	60
Jamaica	—	—	102
Mexico	—	9,143	22,424
Nicaragua	—	—	207
Salvador	—	—	200
Sub Total	**—**	**9,283**	**24,880**
(South America)			
Argentina	—	—	420
Brazil	9,503	43	—
Colombia	—	—	2,850
Ecuador	—	—	10
Peru	—	1,040	5,165
Venezuela	—	—	141
Sub Total	**9,503**	**1,083**	**8,586**
(Africa)			
Egypt	—	—	15
Kenya	—	—	402
Mauritius	—	—	5
Sudan Rep.	—	—	250
Union of South Africa	—	—	1,378
Sub Total	**—**	**—**	**2,050**
(Europe)			
Denmark	—	—	1
Spain	200	400	—
Sub Total	**200**	**400**	**1**
(Middle East)			
Iran	1,000	—	1,500
TOTALS	**111,508**	**166,894**	**306,640**

Japan — Exports (continued)

AMMONIUM CHLORIDE

Country	1957	1958	1959
(Asia)			
China	16,161	23,462	—
Hong Kong	—	280	5
Korean Rep.	—	—	6
India	623	—	—
Indonesia	2	—	—
Thailand	—	—	40
Viet Nam	—	—	54
Sub Total	**16,786**	**23,742**	**105**
(Pacific Islands)			
Formosa	1	1,157	—
Philippines	2	37	29
Sub Total	**3**	**1,194**	**29**
(South America)			
Argentina	20	—	—
TOTALS	**16,809**	**24,936**	**134**

CALCIUM CYANAMIDE

Country	1957	1958	1959
(Asia)			
China	—	250	—
Korean Rep.	—	3,919	46,100
Singapore	—	—	10
Sub Total	**—**	**4,169**	**46,110**
(Pacific Islands)			
Marianas	—	—	1
Ryukyu Is.	67	82	75
Sub Total	**67**	**82**	**76**
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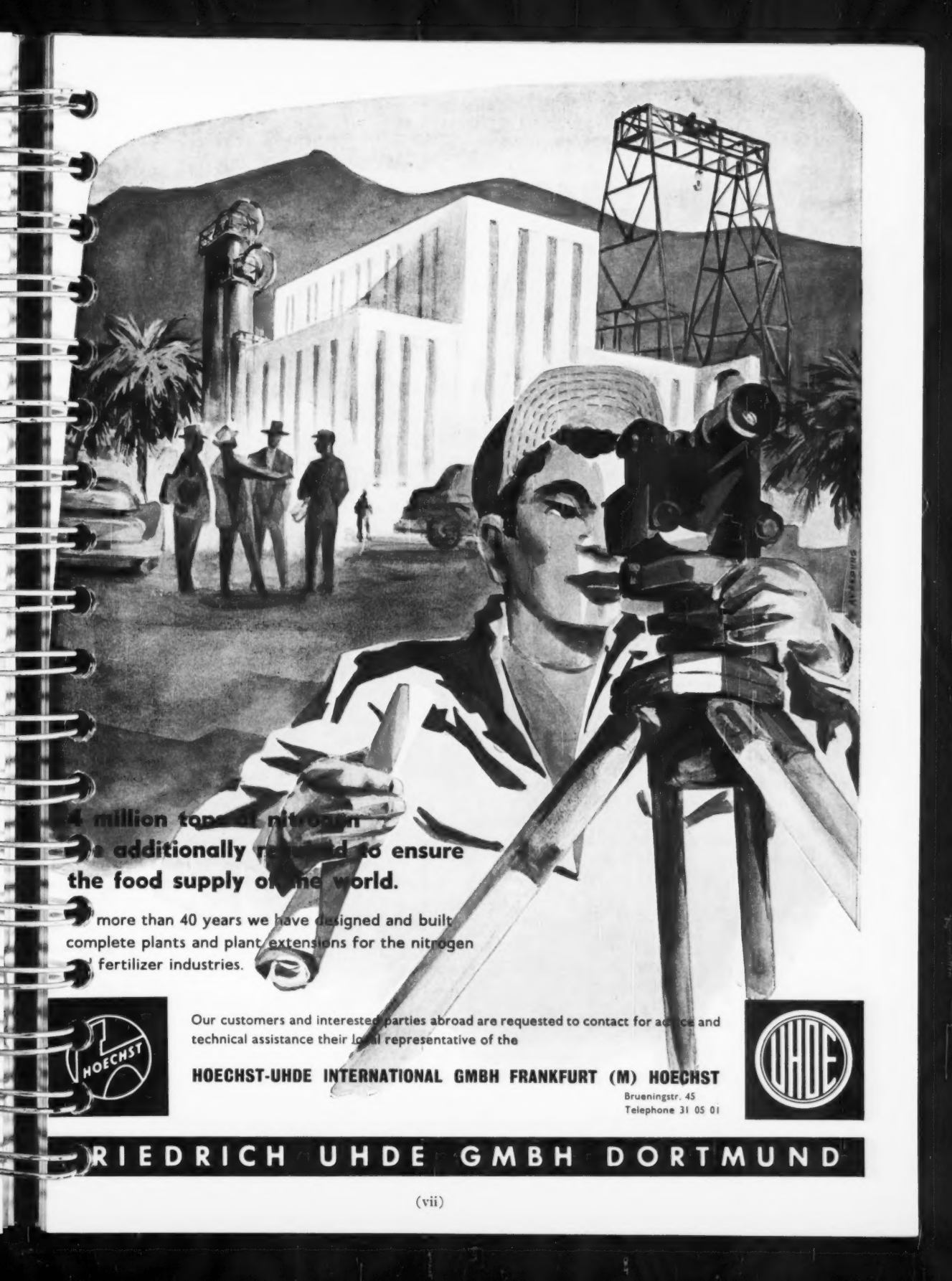
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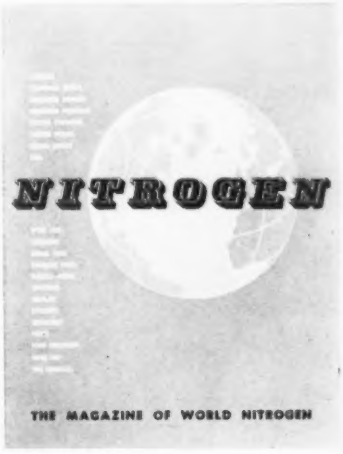

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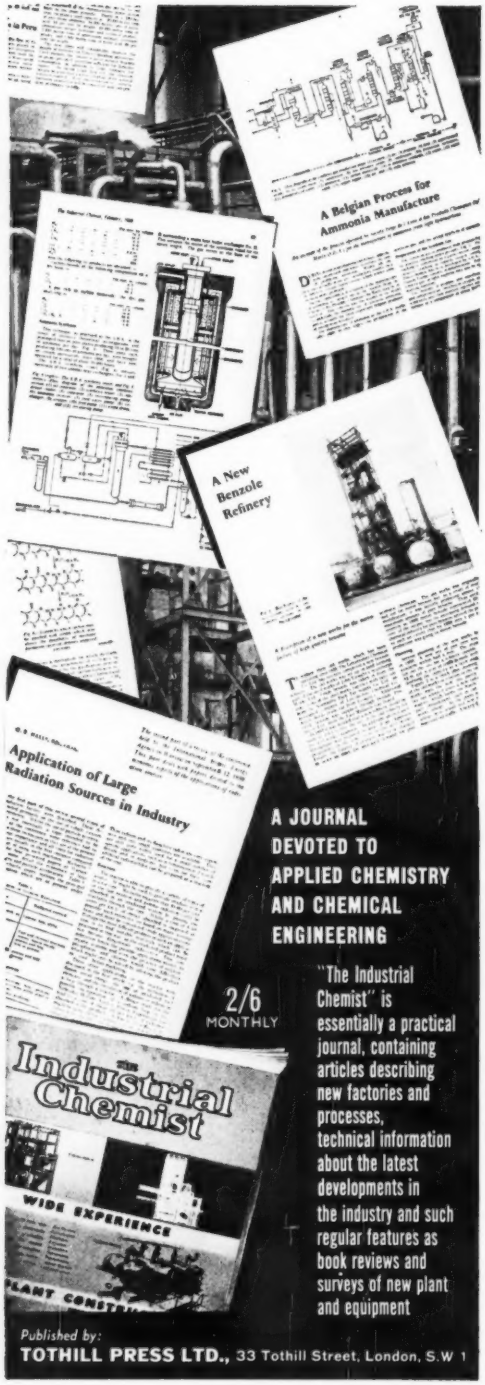
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TRADE DIRECTORY OF THE CHEMICAL INDUSTRY

in the Federal Republic of Germany and West Berlin

incorporating WENZELS DIRECTORY and COMMODITY GUIDE

This directory, published in conjunction with the Association of German Chemical Manufacturers is the only official and comprehensive trade directory embracing both firms and products, following the amalgamation of the former two recognised manuals. It contains fullest information on chemical concerns and their manufactures, in West Germany and West Berlin, and is an essential reference work for all firms and business houses engaged in trading or seeking to expand their trade with the German chemical industry. **Price £4-15-0 or U.S. $12**

The Trade Directory of the Chemical Industry contains the following sections:

List of firms

More than 3,200 chemical manufacturers and commercial concerns are listed alphabetically, together with full addresses and details of supply programmes.

Local index

All firms contained in the alphabetical index have been listed according to town and district, an invaluable aid to both foreign and domestic buyer.

List of products

Manufacturers of each individual product of all German chemical concerns located in West Germany and in West Berlin, together with the respective commercial firms, are listed under more than 10,000 headings.

Registered trade names

The most comprehensive list so far published of about 4,000 registered trade names together with details of products supplied by the manufacturing firms.

ENGLISH, FRENCH and SPANISH TRANSLATIONS of products and indexes greatly facilitate use by foreign firms.

Econ-Verlag GMBH
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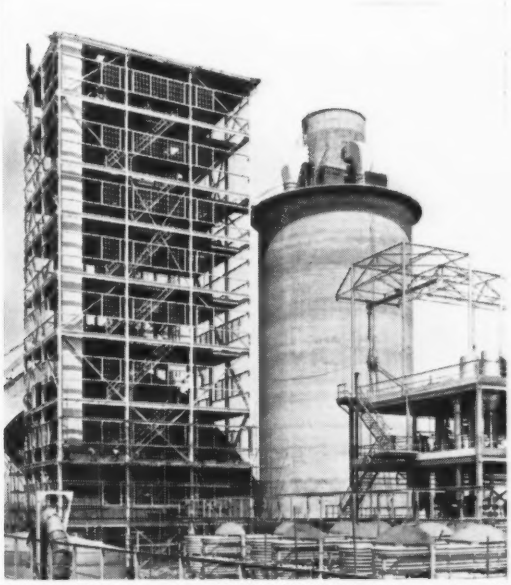
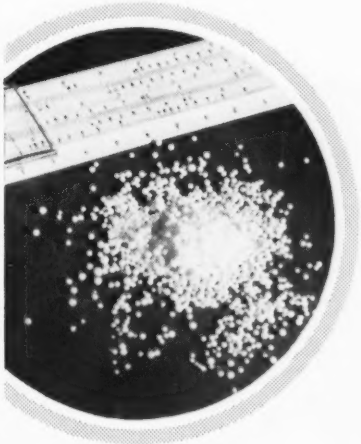
Urea plant at Modderfontein, South Africa, during erecting



300 tons of Urea per day



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